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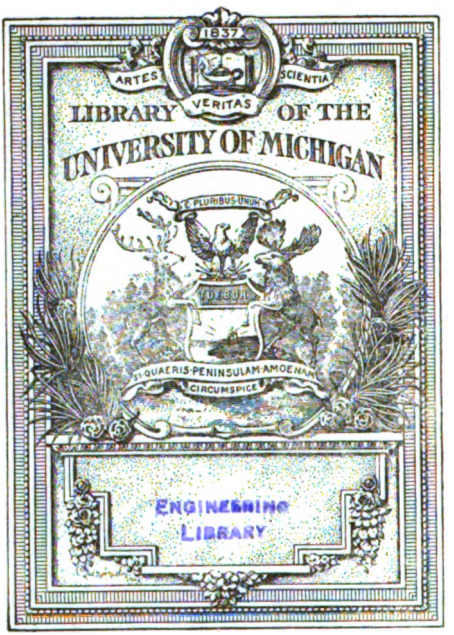

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50TH CONGRESS, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. 1, pt. 2, vol. II.

ANNUAL REPORT

OF THE

CHIEF OF ENGINEERS,

UNITED STATES ARMY,

TO THE

SECRETARY OF WAR,

FOR

THE YEAR 1887.

IN FOUR PARTS.

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C. B. COMSTOCK, Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.,
CHARLES R. SUTER, Major of Engineers, U. S. A.,
Mr. HENRY MITCHELL, Coast and Geodetic Survey,
Mr. B. M. HARROD, Civil Engineer,
Mr. S. W. FERGUSON, Civil Engineer,
Mr. ROBERT S. TAYLOR,
Commissioners.

1.

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CHARLES R. SUTER, Major of Engineers, U. S. A., *President.*
ALEX. MACKENZIE, Major of Engineers, U. S. A.,
O. H. ERNST, Major of Engineers, U. S. A.,
Mr. G. C. BROADHEAD,
Mr. WILLIAM J. BROATCH,
Commissioners.

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APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

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APPENDIX B B.

IMPROVEMENT OF TENNESSEE AND CUMBERLAND RIVERS, AND OF CERTAIN RIVERS IN EASTERN TENNESSEE AND KENTUCKY.

REPORT OF LIEUTENANT-COLONEL J. W. BARLOW, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Tennessee River.
2. French Broad River, Tennessee.
3. Little Tennessee River, Tennessee.
4. Hiawassee River, Tennessee.
5. Clinch River, Tennessee.
6. Duck River, Tennessee.
7. Cumberland River, Tennessee and Kentucky.
8. South Fork of Cumberland River, Kentucky.
9. Caney Fork River, Tennessee.

EXAMINATIONS.

10. Caney Fork River, Tennessee.
11. Holston River, Tennessee.

ENGINEER OFFICE, U. S. ARMY,
Chattanooga, Tenn., August 31, 1887.

SIR: I have the honor to transmit herewith the annual reports upon the river and harbor improvements in my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieutenant-Colonel of Engineers.

CHIEF OF ENGINEERS, U. S. A.

B B 1.

IMPROVEMENT OF TENNESSEE RIVER.

1.—ABOVE CHATTANOOGA (189 MILES).

The Tennessee is now considered as formed by the junction of the waters of the Holston and French Broad rivers, at a point about 4½ miles above Knoxville.

From Knoxville to Chattanooga, about 189 miles, the river is navigable the greater part of the year.

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The examinations made in 1830 and 1872 show that the principal obstructions are rock-reefs and sand and gravel shoals. The bed and banks of the river are of such character as to make the improvements practically permanent.

The present plan of improvement is to blast a channel through the reefs, and to build riprap dams to contract the water-way, so as to secure a safe navigable channel having a depth of about 3 feet at low water.

The only work done in the channel during the fiscal year was that of repairing two of the dams at Upper Half Moon Island so as to obtain an increased depth of water over the shoals.

At this obstruction, 466 cubic yards of stone were quarried, and 390 cubic yards were used in repairing and raising the dams; also 2 snags were taken out.

The necessary flat-boats were built and work will be begun in the channel during the low-water season, which, as a matter of economyin plant and superintendence, is to be carried on in connection with the work in progress upon its tributaries, the Clinch and French Broad rivers.

The construction of a snag and tow boat was begun in March, under contract, and is now nearly completed, for use upon the Tennessee and its upper tributaries.

We have no reliable data showing the commerce of the Upper Tennessee at the time improvements were begun in 1872, under the present project and estimates.

Its commerce is growing rapidly, and at present consists principally of logs, lumber, grain, iron ore, forage, live stock, and general merchandise.

The table of "Commercial Statistics" herewith is necessarily made up largely of the commerce of the tributary streams to the Upper Tennessee, which is increasing yearly.

The prospective advantages to navigation as well as present benefits to the community, by completing the improvement, are the securing an improved channel and a lengthened season of navigation, together with a practical enjoyment of the commercial advantages resultant from the early opening of the canal around the Muscle Shoals of the Lower Tennessee.

The amount available and the appropriation herein asked for can be profitably expended in repair and extension of dams already built, and in continuing channel excavation, building dams, etc., at the most serious obstructions, as provided by the existing project.

The estimates for improving Tennessee River above Chattanooga, as modified and increased from 1871 to 1874	$300,000.00
Amount appropriated	226,000.00
Amount expended	220,725.10

Money Statement.

July 1, 1886, amount available	$57.14	
Amount appropriated by act approved August 5, 1886	7,500.00	
		$7,557.14
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,230.63	
July 1, 1887, outstanding liabilities	51.61	
		2,282.24
July 1, 1887, amount available		5,274.90

Amount (estimated) required for completion of existing project	74,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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II.—BELOW CHATTANOOGA (456 MILES).

The Tennessee River is one of the most important streams tributary to the Mississippi system. It enters the Ohio near Paducah, Ky., and is navigable from Chattanooga to its mouth, excepting at the Muscle Shoals, in Alabama, which form a complete barrier, except when the water is at its highest stages. There are other obstructions, more or less difficult and dangerous, which require further examination, and detailed plans for their removal or modification.

The opening of the Tennessee River by means of a canal around the Muscle Shoals was favorably considered for many years by the General Government before action was taken in the matter.

In 1824, during the administration of President Munroe, the then Secretary of War, John C. Calhoun, asserted that the proposed improvement of the Lower Tennessee was of great national importance.

In 1827 the Board of Internal Improvement, Brig. Gen. S. Bernard, Lieut. Col. James Kearney, and Maj. William Tell Poussin examined that portion of Tennessee River extending from Brown's Ferry to Waterloo, Ala., and made its report in May, 1828. Congress during the same month granted to the State of Alabama 400,000 acres of United States lands to be applied principally to the improvement of the navigation of the Muscle Shoals and Colbert Shoals.

The Board of Internal Improvement in April, 1830, submitted a project consisting of a canal from Brown's Ferry to Florence, and of the removal of obstructions from Florence to Waterloo, about 28 miles.

The canal around Big Muscle Shoals section was begun in 1831, and opened in 1836, but was not built according to the project of the Board nor properly completed, and it was in use only a short time, having been practically abandoned the following year.

In 1867 an examination was made from Chattanooga, Tenn., to Paducah, Ky.

An instrumental survey of the three divisions of the entire chain of obstructions known as the Muscle Shoals was completed, and upon that the present project is based, modified, however, as to the character of work done at Little Muscle Shoals and as to the change of location of the canal from the north side to the south side of the river at Elk River Shoals.

The resurvey of the last-named division was made in 1877.

The Muscle Shoals extend from deep water at Brown's Ferry to deep water at Florence, a distance of 38 miles, only 8 miles of which were navigable.

From Chattanooga, Tenn., to Decatur, Ala., the section of river above the Muscle Shoals, there is much work to be done at several of the obstructions, especially at the "Suck" and the Bridgeport and Guntersville bars.

Below the Muscle Shoals, from Florence, Ala., to the mouth of the river, the principle obstructions are at Colbert Shoals and Duck River Shoals, though there are other obstacles of minor importance that require attention.

As the Muscle Shoals, the rocky barrier that effectually closes navigation, must necessarily be overcome before the river above can be utilized to any great extent, it has been heretofore for this reason held advisable to press forward that work to completion before submitting any projects and revised estimates for the radical improvement of other portions of the channel, either above Decatur or below Florence.

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The existing project, with estimates, is—

(1) To enlarge, rebuild, and straighten the old work at Big Muscle Shoals by constructing a canal 14½ miles long, having 9 locks with a total lift of 85 feet, and an aqueduct 900 feet long and 60 feet wide over Shoal Creek, with the necessary permanent dams and bridges over the several creeks and ravines, the canal trunk to be from 70 to 120 feet wide at the water surface and 6 feet deep, and the locks 300 feet long, 60 feet wide, and having a depth of 5 feet of water on the miter-sills.

(2) To construct at Elk River Shoals a canal 1½ miles long, with 2 locks having lifts of 12 feet and from 5 feet to 9 feet, respectively, and of same dimensions as the locks at the Big Muscle Shoals.

(3) To blast at Little Muscle Shoals a channel through the bed-rock of the river, and to construct stone wing-dams and retaining-walls to contract the water-way and to check the velocity of the current at certain points.

(4) To remove or reduce the worst obstructions above Decatur and below Florence to the limited extent that may be imperative to assist low-water navigation, having in view the submission of plans and revised estimates for a radical improvement of the various obstructions.

At Little Muscle Shoals the project is practically completed at a cost of $126,180. A channel about 2½ miles long has been blasted out, and about 3 miles of permanent stone dams built; but, as stated in the annual report for 1886, "the current is strong and the velocity, combined with other causes, may require that further work be done on this section, either by the construction of locks," as originally provided for in the estimates, "or by a modification of the present system of dams."

During the fiscal year the work at the Big Muscle Shoals was efficiently carried on under the local charge of Assistant Engineer Robert Hooke, until his resignation in April, and from that time in charge of Assistant Engineer W. A. Toms, until his sudden death in the vicinity of the works (July 28), of sickness incident to the malarial character of the locality and contracted during his continuous and faithful service, extending from the beginning of the work in 1875.

The principal work done during the year has consisted in placing in position the iron gates of locks 4 to 9, inclusive; in the construction of the Shoal Creek Aqueduct, and the permanent dams of rubble masonry at Second Creek, Bluewater Creek, Helltown, and Four-Mile Creek.

Some work was done in the prism of the canal, on each section throughout its entire length of eleven sections; rock excavations on sections 1, 3, 9, and 11, and earth, sand, and gravel excavation on the other seven sections.

The following shows the work done during the fiscal year, viz:

Lock 1.—Culvert valves put in; miter-posts put on lower gates; rods, A frames, and gates painted.
Lock 2.—Culvert valves put in; miter-posts put on gates; gates, rods, and A frames painted.
Lock 3.—Lower gates suspended; miter-posts put on gates; gates, A frames, and rods painted.
Lock 4.—Upper and lower gates suspended, and mitre posts put on; gates, A frames, rods, and upper cushion timbers painted.
Lock 5.—Lower gates suspended and painted, and miter-posts put on.
Lock 6.—Lower gates, A frames, and rods painted; culvert valves put in.
Lock 7.—Lower gates suspended and painted; culvert valves on south side put in.
Lock 8.—Lower gates suspended and painted.
Lock 9.—Lower gates erected, suspended, and painted.

Miter-post cushion timbers were put in at all the locks, except at Lock 5, where the holes are drilled, and cushion timbers ready to be bolted down.

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Shoal Creek Aqueduct.—The work of drilling and riveting the I beams and plates was continued; 407 bottom plates were riveted, 72 side plates punched, and 28 drilled. All the bottom beams and plates drilled ready for the angle-irons, all the angle-irons punched, and 44 side-plates riveted to them. Dowel-holes were drilled in north ends of the piers to secure the upper courses of masonry in position; 281 tension-braces were sheared and bent to proper form; 19 spans of the bottom of the aqueduct inside were painted.

The construction of the maneuvering appliances for the lock gates and culvert valves is well advanced, and they will soon be ready for adjusting and placing in position.

Location.	Excavation.				Embankment.	Stone cut.	
	Earth.	Solid rock.	Loose rock.	Sand and gravel.		Cut stone.	Rock face.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Section No. 1			565				
2				120			
3	440	30	260	480			
4							
5				11,180	4,574		
6				11,517			
7				5,532			
8				2,804	50		
9			240				
10							
11	22,801	851	5,342		36,133		
Second Creek Dam	250		20				302.5
Bluewater Dam				700		100	82.3
Helltown Dam							63
Four-Mile Creek Dam				1,000			114
Total	23,491	851	6,427	33,283	40,757	100	561.8

Location.	Masonry laid.			Stone quarried.	Stripping.	Coffer-dams.	Clearing and grubbing.	Boating sand.
	Cut stone.	Rubble.	Dry rubble.					
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*			*Cu. yds.*
Section No. 1							1 mile	
2							1 mile	
3								
4			234	245				
5			1,115	420				
6			580	70			1,300 lin. ft. 5½ acres	
7							700 lin. ft.	
8								
9								
10							11 acres	
11							¾ mile	
Second Creek Dam	244.7	311		805	495	150 lin. ft.		150
Bluewater Dam		90		745	65	450 cu. yds.		32
Helltown Dam	75	229		20				
Four-Mile Creek Dam	130	274		160				40
Total	449.7	904	1,949	2,465	560	150 lin. ft. 450 cu. yds.	3½ miles 16½ acres	220

Plans have been prepared for the five drop-gates, and preparations are in progress for their construction.

It is expected that these gates will be completed and the entire lockage of this section finished by January, 1888, but the opening of the canal to navigation can hardly be accomplished with the funds now

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available, and an additional appropriation is urgently required for this purpose.

The building of a dredge-boat was begun in May, at a cost of about $10,000, for use upon the Tennessee, principally in dredging the channel entrances to the canal and in keeping clear the canal trunk, etc.

The hull and cabin is building under contract, and the dredge complete will probably be ready for use in August.

A snag and tow boat, costing $6,340, is also in process of construction under contract, to be used upon the Tennessee and its upper tributaries.

A survey along the Muscle Shoals Canal was made by Lieut. H. E. Waterman, Corps of Engineers, for the purpose of determining—

(1) The amount of land cut off by the canal from the main land.

(2) The amount of land to be overflowed when water is let into the canal.

(3) To determine suitable sites for superintendent's quarters, machine-shops, lock-keeper's dwellings, etc.

This work was well executed; the maps show the section lines as they were located by the original land office survey, and give also the areas cut off or flooded by the construction of the canal.

This information will be needed in adjusting the question of claims for damages which owners of property along the canal are liable to make when the canal becomes used for navigation.

The actual payments made during the fiscal year, pertaining and properly charged to this division, amount to $105,932.29.

The principal disbursements being for account of—

Pay-rolls	$65,540.50
For subsistence of employés	10,939.00
Paid for steel plates	11,592.64
Supplies, etc., U. S. Engineer railroad	6,627.44
Miscellaneous supplies	10,095.65

And the balance for numerous contingencies: advertising, traveling expenses, rents, etc., pertaining to the work.

THE COST IN ROUND NUMBERS OF SOME OF THE PRINCIPAL LABOR-WORK DONE, BASED ON COST OF LABOR AND ITS SUBSISTENCE ONLY.

Drilling and riveting beams, plates, etc., at Shoal Creek Aqueduct	$5,677
Work on lock-gates, as stated	5,704
On sections, earth-work	24,583
On sections, stone-work	6,125
Second Creek Dam	9,215
Bluewater Creek Dam (unfinished)	6,042
Four Mile Creek Dam	1,196
Helltown Dam	1,796

At the *Elk River Shoals* the work was carried on under the local direction of the late assistant engineer, W. A. Toms, until April, since which time this division has been in local charge of Mr. Wm. A. Barlow, assistant engineer.

The principal work done consisted of laying masonry of Locks A and B, excavating the canal trunk and channel entrance to Lock B, building embankment back of the walls of and slope wall below Lock A, constructing dams above Lock A, and from Milton's Bluff to Burkett's Island, etc; also work pertaining to setting up and anchoring the lock-gates, drilling, riveting, etc.

A large quantity of miscellaneous work was also done by the working force of this division: boating cement, iron beams, plates, coal, timber,

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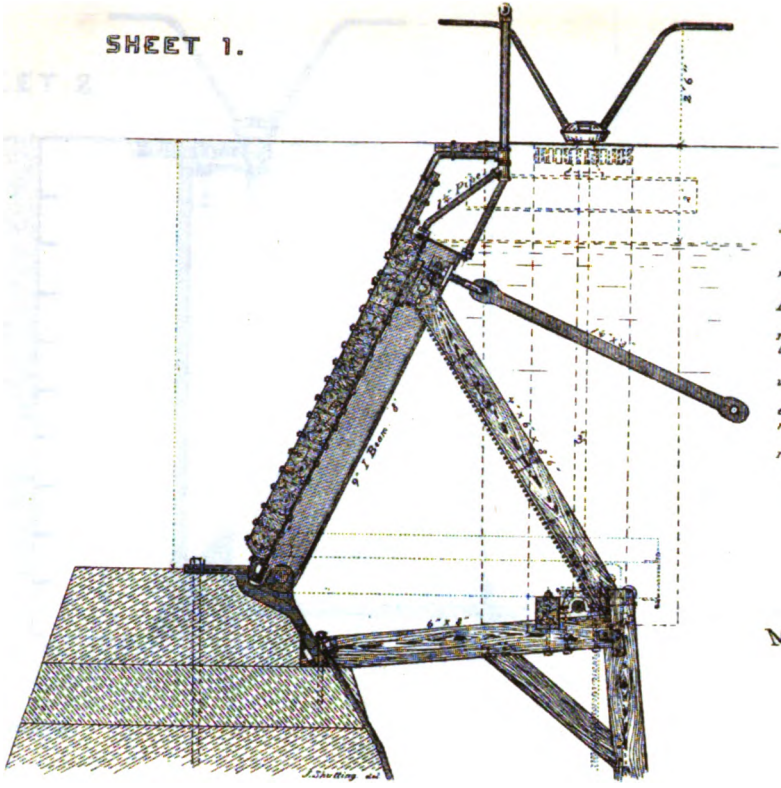
SHEET 1.



To accompany my Annual Report for 1887.

J.W. Barlow
Lt Col of Engrs

Explanation:

12 - 9" Steel I Beams 5' apart with Steel Pin in Cast Iron Socket.
12 Cast Sockets 6" wide supporting Beams.
Cast Heel Plate resting against masonry and Cast Sockets when Gate is raised
Timber 6" thick bolted to flange of I Beams.
8 Wooden Trestles carrying Maneuvering Shaft and supporting Gate when lowered.
2 Maneuvering Spars with Racks moved by Pinions on Shaft.
1 - 3" Shaft supported on Trestles, one end passing through lock wall and mitred to upright Shaft.
4 Anchor Chains to support Gate when raised.
Foot Bridge supported on 8 Pipe Brackets.

DROP GATE
for
Muscle Shoals Canal Locks.

Designed by

Lt. Col. J.W. Barlow.
Corps of Engineers.

Scale : ¾ inch = 1 foot.

AUG. 1887.

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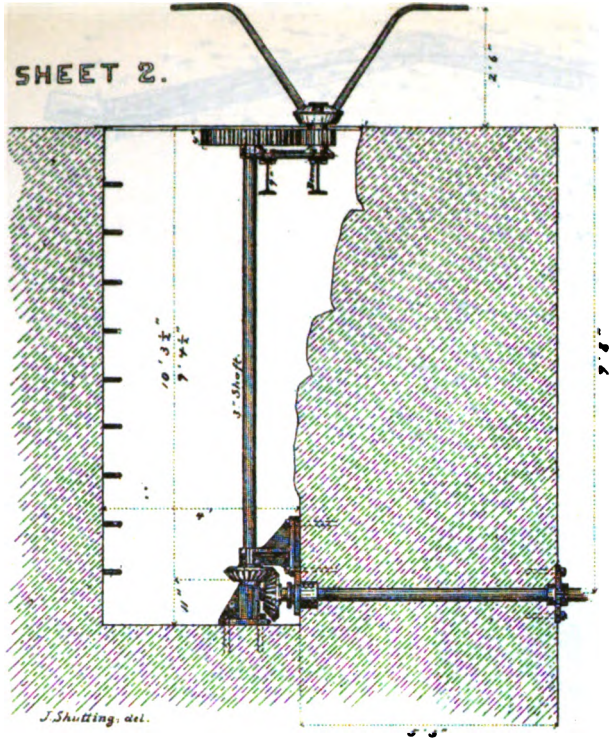
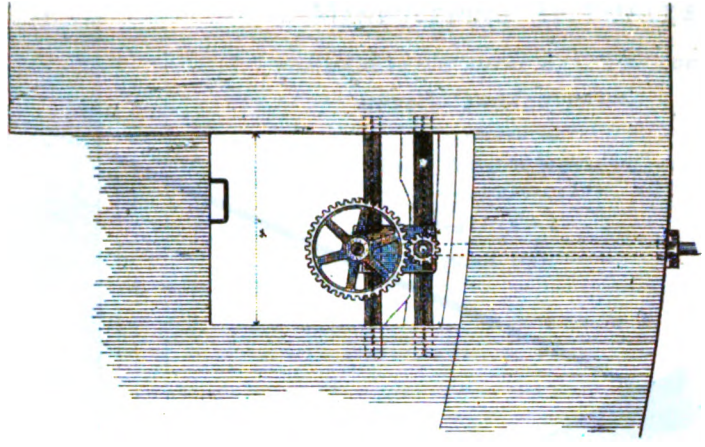
Section and Elevation.



Plan.



MANEUVERING GEARS FOR DROP GATES

OF THE FIVE LOWER LOCKS,

MUSCLE SHOALS CANAL.

DESIGNED BY Lt.Col. J.W. Barlow, CORPS OF ENG'RS.

Scale ¼" = 1'.

Nov. 1887.

To accompany my
Annual Report for 1887.
J.W. Barlow
Lt Col of Engrs

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SHEET 3.

PLAN OF

MANEUVERING APPLIANCES

FOR OPERATING MITRE GATES OF LOCKS,

MUSCLE SHOALS CANAL.

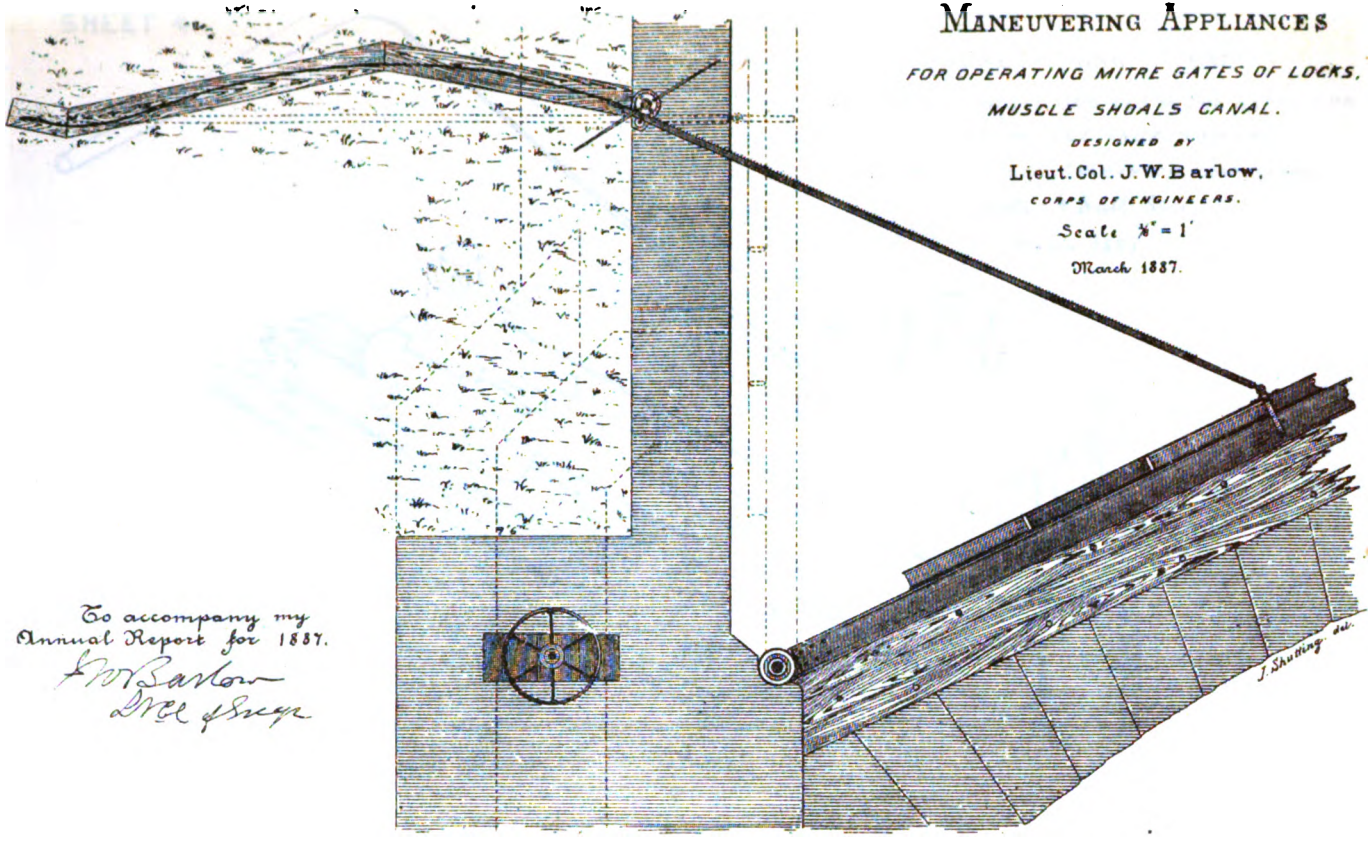
DESIGNED BY

Lieut. Col. J. W. Barlow,

CORPS OF ENGINEERS.

Scale ¾" = 1'

March 1887.



To accompany my
Annual Report for 1887.
J. W. Barlow
Lieut Col Engrs

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SHEET 4.

ISOMETRIC DRAWING SHOWING THE

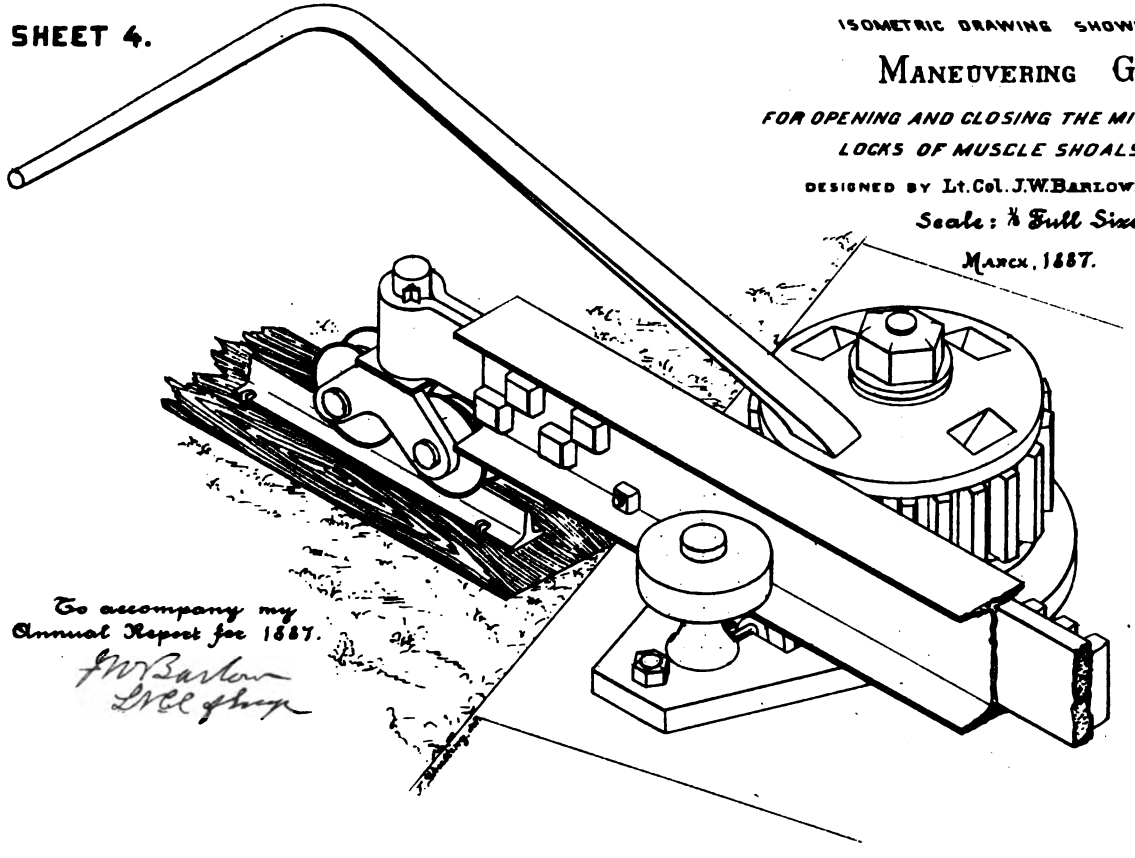
MANEUVERING GEAR

FOR OPENING AND CLOSING THE MITRE GATES FOR LOCKS OF MUSCLE SHOALS CANAL.

DESIGNED BY Lt. Col. J.W. BARLOW, CORPS OF ENG.

Scale: ½ Full Size.

MARCH, 1887.



To accompany my Annual Report for 1887.

J.W. Barlow
Lt Col Engrs

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etc., from Decatur to Milton's Bluff, thence to the head of Muscle Shoals Canal, from time to time, as the stage of water permitted.

	Location.					
	Canal trunk.	Lock A.	Lock B.	Dams.	Snags removed.	Total.
Excavation:						
Earth.....cubic yards..	64,791	.....	50	.....	.....	64,841
Solid rock.....do....	385	.....	.....	.....	.....	385
Sand and gravel.....do....	.....	.....	20	.....	.....	20
Back of lock-walls:						
Embankment.....do....	.....	2,000	.....	.....	.....	2,000
Stone cut:						
Cut stone.....do...	.....	9.8	43.8	.....	.....	53.6
Rock face.....do....	.....	.....	120.2	.....	.....	120.2
Masonry laid:						
Cut stone.....do....	.....	19.8	339.4	.....	.....	359.2
Rubble.....do....	1,079.7	8	509.6	1,068	.....	2,665.3
Dry rubble.....do....	2,096	.....	.....	2,693	.....	4,789
Stone quarried.....do....	3,447	225	332	3,016	.....	7,020
Quarry, stripping.....do....	360	.....	562	210	.....	1,132
Clearing and grubbing.....acres..	18	.....	.....	.....	.....	18
Boating sand and earth....cubic yards..	.....	.....	.....	610	.....	610
Drift-wood, snags, etc., removed.....	.....	.....	.....	.....	9,332	9,332

The actual payments made during the fiscal year, pertaining and properly chargeable to this division, amount to $54,574.46.

The principal disbursements being on account of—

Pay-rolls	$41,620.60
Subsistence of employés	5,520.20
Miscellaneous supplies	5,275.44

And the balance for the contingencies pertaining to the work.

THE COST IN ROUND NUMBERS OF THE PRINCIPAL LABOR-WORK DONE, BASED ON COST OF LABOR AND ITS SUBSISTENCE ONLY.

Work on lock-gates and masonry	$7,778
Dams, stone-work	7,856
Canal clearing and excavation	29,235
Moving I-beams, steel plates, and heavy materials to Muscle Shoals	2,859

The operations upon this divison are so well advanced, that an effort will be made to open the Elk River Shoals Canal before the close of 1887 to the extent of making it available for use by the United States in the transportation of the main supplies needed for the lower division, thus reducing the heavy outlay for freights by railroad.

An instrumental survey of the Tennessee River from Chattanooga, Tenn., to Decatur, Ala., and from Florence, Ala., to Paducah, Ky., is very necessary, and should be made without delay, in order to obtain a profile map of the river with detail maps of the obstructions on the above-mentioned sections, so that estimates can be revised and projects for their radical improvement submitted based upon the necessary and definite data that can only be thus obtained.

In view of the early completion and opening to general commerce and navigation of both sections of the Muscle Shoals Canal, it is desirable that the major obstructions, either above or below the canal, should receive prompt consideration and action.

This is especially true of the Colbert Shoals, an obstruction for which immediate provision should be made, so that the canal itself can be more fully utilized.

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These shoals are 6 miles long, and only 11 miles below Florence. During the boating season the depth on Colbert Shoals runs from 3½ feet to 8 feet, not including flood stages; but during the low-water season of 1884 it is reported that only a depth of 10 inches was available for three months.

The aqueduct of the Muscle Shoals provides for a depth of 5 feet, the least depth found on the line of the canal, so that depth should properly determine the low-water stage over the Colbert Shoals, where the current is very rapid, and this may necessitate, even as a matter of economy, the construction of a lock and dam.

The last appropriation for the Tennessee River below Chattanooga limited its expenditure to the Muscle Shoals improvement, therefore it rests in the judgment of Congress to determine to what extent, if any, work should be carried on for the improvement of Colbert Shoals in connection with the completion of the main work at the Muscle Shoals.

A report of the obstructions caused by the bridges spanning this river has been already submitted to Congress, and published in Ex. Doc. No. 45, Senate, Forty-ninth Congress, second session.

The commerce of the Tennessee River below Chattanooga, above and below Muscle Shoals, is shown in the accompanying tables as correctly and definitely as it can be ascertained.

The commerce consists largely of like products to those which formed the staples before the improvements were begun, though in increasing quantities since that time.

So far as ascertained, the work thus far executed has had no appreciable effect upon insurance or freight rates, the latter being controlled by the competing steamboats plying upon the river; though some instances are of record where greatly reduced rates have been obtained from the railroad to terminal points because of the improved condition of the channel at the upper entrance to the Elk River Shoals Canal.

The prospective advantages to navigation, as well as present benefits to the community, by continuing the improvement to completion, not alone of the Muscle Shoals and the Colbert Shoals, but of the entire stream below Chattanooga, is held to be by the inhabitants of the Tennessee Valley well-nigh incalculable.

The whole region is rapidly developing as one of the richest in coal and in iron and other mineral deposits, and all that seems necessary to the further development of these unquestioned resources is cheap transportation and an open river to the commercial centers of the Mississippi Valley.

It is desirable that action should be taken to procure sites upon which to erect such permanent buildings, superintendent's and lock-tender's quarters, repair shops, etc., as will be required for operating the canal; therefore attention is respectfully recalled to House Ex. Doc. No. 23, Forty-ninth Congress, second session, in which was submitted a statement of the matter, and which was recommended by the honorable the Secretary of War for the favorable action of Congress.

The funds available and the amount herein asked for can be profitably expended in completing the work at the Big Muscle Shoals and the Elk River Shoals, so that the canal can be put in a navigable condition and opened without delay.

The work remaining to be done consists of excavating in canal prism upon both divisions, in adjusting the maneuvering appliances of the lock-gates, placing culvert-valves in position, constructing and placing the drop-gates of the five lower locks, completing the superstructure of the Shoal Creek Aqueduct, building permanent dams and bridges

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needed at various points, and much miscellaneous work incident to its near completion.

If provision be made therefor, a part of the amount asked for can be profitably expended in the improvement of the Colbert Shoals, the Little Muscle Shoals, and the sand-bars at Bridgeport and Guntersville, in completing the dams at Tuscumbia Shoals, and in removing surface obstructions in the lower river, and in making an instrumental survey of the river from Chattanooga, Tenn., to Decatur, Ala., and from Florence, Ala., to Paducah, Ky.

Estimates of cost of improving the Tennessee River below Chattanooga	$4,133,000.00
Amount appropriated	2,958,000.00
Amount expended	2,863,116.87

Money statement.

July 1, 1886, amount available		$5,660.26
Amount appropriated by act approved August 5, 1886		262,500.00
		268,160.26
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$151,914.13	
July 1, 1887, outstanding liabilities	21,363.00	
		173,277.13
July 1, 1887, amount available		94,883.13
Amount (estimated) required for completion of existing project		1,175,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for the construction of a snag and tow boat, opened at Chattanooga, Tenn., on the 12th day of February, 1887, by Lieut. Col. J. W. Barlow, Corps of Engineers.

No.	Name and address of bidder.	Boat complete.	Hull.	Machinery.	Remarks.
1	Ed. J. Howard, Jeffersonville, Ind	$7,650			
2	Truxal & Dunmeyer, Chattanooga, Tenn.			$4,565	No guarantors. No justification.
3	A. R. Perry, Chattanooga, Tenn		$3,300		
4	M. A. Sweeney & Bro., Jeffersonville, Ind.	*6,590	3,300	3,290	Accepted.

* Modified to $6,340. See M. A. Sweeney & Bro.'s letter of February 15, 1887.

Abstract of proposals for the construction of dredge-boat hull and cabin, opened at Chattanooga, Tenn., on the 27th day of April, 1887, by Lieut. Col. J. W. Barlow, Corps of Engineers.

No.	Name and address of bidder.	Price.	Remarks.
1	M. A. Sweeney & Bro., Jeffersonville, Ind	$5,185.60	
2	A. R. Perry, Chattanooga, Tenn	2,800.00	Accepted.

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COMMERCIAL STATISTICS.

Tennessee River above Chattanooga, from July 1, 1886, to June 30, 1887,

Articles.	Quantities.	Articles.	Quantities.
Iron ore ..... tons..	74,607	Sand ..... cubic yards..	6,090
Grain ..... bushels..	783,465	Stone ..... do	4,998
Coal ..... tons..	32,780	Wood ..... cords..	2,928
Hay and straw ..... do...	136,998	Shingles ..... M..	237.750
Live stock ..... head..	87,080	Flour ..... barrels..	3,329
Logs ..... feet B. M..	28,303,931	General merchandise ..... pounds..	5,817,937
Lumber ..... do...	12,755,570	Passengers ..... number..	63,368

The above statistics were obtained under the direction of the engineer officer in charge from the steam-boat manifests, flat-boats, etc., and are accurate, showing the commerce of the Upper Tennessee entering and leaving Chattanooga, Tenn.

List of steamboats plying on Tennessee River above Chattanooga.

Names of boats.	Character.	Length.	Breadth.	Depth.	Tonnage.
A. G. Henry	Stern-wheel...	145	30.00	3.02	249.45
M. H. Clift	....do	105	19.00	2.00	68.63
Rockwood	....do	130	25.00	4.00	226.26
May Tillman	....do	79	15.00	3.00	32.72
Water Lilly	....do	112	21.00	3.00	141.17
J. C. Warner	....do	142	31.06	4.06	347.33
W. S. Dugger	....do	130	27.00	3.08	224.13
Citico	....do	75	13.00	3.00	31.30
Dayton	....do	142	24.07	3.08	357.49
P. Dickinson	....do	122	28.00	4.00	205.97
Myra	....do	100	18.00	3.05	148.42

COMMERCIAL STATISTICS.

Tennessee River, from July 1, 1886, to June 30, 1887.

BELOW CHATTANOOGA AND ABOVE MUSCLE SHOALS.

Articles.	Quantities.	Articles.	Quantities.
Brick ..... number..	13,300	Live stock ..... head..	84,867
Coal ..... tons..	748	Lumber ..... feet B. M..	205,765
Cotton ..... bales..	4,984	Sand ..... cubic yards..	1,239
Flour ..... barrels..	3,375	Tan-bark ..... cords..	780
Grain ..... bushels..	156,895	Merchandise ..... pounds..	13,629,567
Hay ..... tons..	139	Passengers ..... number..	62,699

BELOW MUSCLE SHOALS.

Cotton ..... bales..	42,700	Pig-iron ..... tons..	7,000
Cross-ties ..... number..	15,060	Staves and hoop-poles ... number..	3,000,000
Grain ..... bushels..	760,000	Pea-nuts ..... bags..	119,000
Lumber ..... feet B. M..	11,582,000	Tobacco ..... hogsheads..	2,250
Live stock ..... head..	4,800	Merchandise ..... tons..	15,075

The statistics of the Lower Tennessee show: (1) The commerce below Chattanooga, but above the Muscle Shoals, entering and leaving Chattanooga, which data were obtained from the manifests, etc., by the U. S. Engineer officer at Chattanooga. (2) The commerce below Florence, Ala., which was kindly furnished on application by the Evansville, Paducah, and Tennessee River Packet Company.

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List of steamboats plying on Tennessee River.

BELOW CHATTANOOGA AND ABOVE MUSCLE SHOALS.

Names of boats.	Character.	Length.	Breadth.	Depth.	Tonnage.
J. H. Johnson	Stern-wheel	141.02	23.09	4.02	169.90
Chattanooga	do	133.00	29.06	3.03	248.52
R. C. Gunter	do	158.00	28.00	4.00	565.34
Dixie	do	80.00	19.00	3.00	110.78
M. V. Reed	do	65.00	24.00	3.00	111.25
Herbert	do	134.00	27.00	3.00	167.00

BELOW MUSCLE SHOALS.

John Gilbert	Stern-wheel	250	47	6.00	700
W. T. Nisbet	do	230	44	6.06	625
Silver Cloud	do	207	42	5.00	550
Clyde	do	206	40	5.06	450
W. A. Johnson	do	170	35	4.00	250
City of Florence	do	183	37	5.03	425
City of Sheffield	do	192	37	5.02	460

*SURVEY OF COLBERT AND BEE TREE SHOALS, TENNESSEE RIVER.

ENGINEER OFFICE, UNITED STATES ARMY.
Chattanooga, Tenn., January 9, 1888.

SIR: I have the honor to submit the following preliminary report on the improvement of Colbert and Bee Tree Shoals of the Tennessee River, Alabama, a survey of which, authorized by the Chief of Engineers, was made under my direction by First Lieut. H. E. Waterman, Corps of Engineers, during the months of November and December, 1887.

GENERAL CONSIDERATIONS.

Next to the Muscle Shoals these obstructions are the most serious upon the Tennessee River, and during the low-water season of each year, a period of from four to eight months, almost wholly interrupt navigation.

These shoals are located near the western boundary of Alabama, about 11 miles below the Muscle Shoals, at present an absolute barrier to navigation, but which, under Government appropriations amounting to several million dollars, will soon be made navigable for vessels of 5 feet draught throughout the entire year.

Without a corresponding improvement at Colbert and Bee Tree Shoals the costly canal and locks around the Muscle Shoals will be comparatively useless during a large share of the year.

Above Colbert Shoals large iron manufacturing interests have been recently developed, which demand water transportation for their products, and this having been provided by nature in an almost perfect condition, there is needed but a comparatively small improvement to make it entirely satisfactory.

The force of this statement will be realized upon consideration of the fact that from the Muscle Shoals to the mouth of the river the distance is 255 miles, and with the exception of the obstructions offered by Colbert and Bee Tree Shoals the impediments to navigation are of an in-

*This report having been received prior to the printing of Colonel Barlow's Annual Report for 1887, is here inserted as being of special interest.

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significant character; in fact, the river is navigable to the foot of these shoals throughout the entire year. The propriety therefore of an adequate improvement here, to connect the lower section of the river, some 235 miles in length, with the 400 miles above, seems manifest.

PREVIOUS WORK OF IMPROVEMENT.

From the appropriations made in 1868, '69, and '70, about $35,000 have been expended in efforts to prolong the season of navigation over these shoals. This money was well applied, and resulted in extending the season of navigation considerably, and removing, in a large degree, the previously existing dangers. The means employed were those usual upon shoals of moderate fall, viz, channel excavation, for the purpose of lowering and smoothing the bed of the channel, and narrowing it by spur or wing dams. These efforts seem to have been carried sufficiently far to prove that when the fall is as great as in this case, that a sufficient depth of water can only be gained in this manner by so contracting the channel as to give rise, during low stages of the river, to an insurmountable current. With the improvements now existing, the current is already objectionable, and yet at low water the available depth for several months does not exceed 14 inches.

CHARACTER OF THE SHOALS.

The total fall upon these shoals, as determined by the recent survey, from deep water above the head of Colbert Shoals to deep water below Bee Tree Shoals, a distance of 10.1 miles, is 24.7 feet; of this a fall of 11.7 feet occurs in the first $2\frac{1}{2}$ miles, and the entire fall from there to the foot of Colbert Shoals is 13 feet. Here a pool $2\frac{3}{8}$ miles in length extends to the head of Bee Tree Shoals.

Upon the shoals the river attains a width of 2,000 to 4,000 feet, but immediately below both shoals the banks converge to within about 1,300 feet.

METHOD OF IMPROVEMENT RECOMMENDED.

The only plan which seems to warrant satisfactory results is that of locks and dams, one lock and dam to be located at the foot of Colbert Shoals, the lock having an extreme lift of 15 feet, and requiring a dam about 24 feet high. The pool thus formed will extend up-stream about 4.1 miles, converting the bed of the river into a permanent lake, but not causing overflow to the adjacent country.

The conditions here for an improvement of this kind are remarkably favorable, the banks being high and bold, the river of sufficient though moderate width, and the foundations favorable for permanent structures.

Below Bee Tree Shoals another site for a lock and dam should be selected, the height of dam and lift of lock being 3 feet less than that above.

The conditions here are not quite so favorable, the banks being lower and the foundations less perfect. These difficulties can be overcome, but will add somewhat to the cost of the work.

ESTIMATES OF COST.

The dams should be built across the river and upon the most favorable line—cost and permanence being considered.

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Timber-cribs filled with stone would probably be the most economical method of construction in this locality. The height should be just sufficient to overcome the fall upon the shoal and afford the required depth at the head.

The locks should be of cut-stone masonry, their dimensions being at least those of the locks built in the Muscle Shoals Canal, viz., 300 feet by 60 feet, interior dimensions.

This is a matter of detail, however, which should be determined after full consultation with the river men in regard to the size and kind of craft which will be likely to use the locks.

An approximate estimate of the cost of each lock and dam can only be submitted in this report, as the maps of the survey have not yet been completed, nor the exact design of the structures determined.

APPROXIMATE PRELIMINARY ESTIMATES.

Lock No. 1, 300 by 60 feet, walls 33 feet high		$314,000.00
Lock No. 2, 300 by 60 feet, walls 37 feet high		379,750.00
Cost of locks about		693,750.00
Dam No. 1. 1,285 feet long, at $95 per linear foot	$122,075	
Dam No. 2, 1,130 feet long, at $95 per linear foot	107,350	
Cost of dams about		229,425.00
Total cost of projected improvement		923,175.00

Herewith are transmitted the preliminary report of First Lieut. H. E. Waterman, Corps of Engineers; a profile of the river prepared from the notes of his survey and a tracing from a survey made under the direction of the late General G. Weitzel, Corps of Engineers, in 1868. The latter is sent to show the general outline of the river at the point under consideration.

Lieutenant Waterman's estimate of the cost of the two locks is believed to be about right, though a further study of the maps and location may modify and possibly reduce it by diminishing the height of the walls.

His estimate for dams should, I think, be increased somewhat, as it is not probable that the materials can be procured and placed in position at the prices named.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT H. E. WATERMAN, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., January 7, 1888.

SIR: I have the honor to submit the following preliminary report on the improvement of Colbert and Bee Tree shoals, Tennessee River. More complete estimates and maps will be forwarded as soon as they can be prepared from the field-notes of the survey.

The improvement permanently of the river at these points will necessitate, in my opinion, the construction of two locks and dams. The fall in Colbert Shoals is about 4.2 feet to the mile and in Bee Tree Shoals 4.7. With the present existing system of longitudinal and spur dams the current is so swift as to render it almost impossible to keep steamboats in a fixed channel, even where one exists.

Two good lock-and-dam sites have been examined, one at the foot of Brush Creek Island, the other just below Waterloo Landing. The main difficulty will be the securing of the base of the dams on solid rock without incurring unusual expense.

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At the upper dam-site the average depth at low water is 7.5 feet, at the lower, 10 feet. In case the dams can be made tight without going down to solid rock these depths can be diminished an average of 2 to 3 feet.

The accompanying profile will explain the character of the river bed and its obstructions, as well as the proposed improvement.

The fall from the head of Colbert Shoals to Dam I, at the foot of Brush Creek Island, is 14.2 feet at low water. This distance is 4.1 miles; hence the following computation of the height of Dam I:

	Feet.
Average depth below low water	7.5
Fall to be overcome	14.2
To this add to secure 6-foot navigation at head of Colbert Shoals	2.1
Total	23.8

Hence the required height of this dam will be about 24 feet.

The fall from this point to the foot of the shoals near Waterloo Landing, a distance of about 6 miles, is 10.5 feet.

Hence for the height of Dam II:

	Feet.
Average depth below low water	10.0
Fall to overcome	10.5
Add to secure 6 feet at head of Bee Tree Shoals	1.3
	21.8

Or about 22 feet as the required height.

These heights give for the lift of the upper lock 15 feet at low water, and for the lower one about 12 feet.

The exact height of the lock-walls, as determined by the discharge of the river, cannot of course be determined without gauging the river at its higher stages.

However, I think from the appearance of the banks that a height of the lock-walls of Lock 1 of 33 feet would be amply sufficient to enable the use of the lock at all stages when boats cannot pass over the dam. Lock No. 2, however, will, I think, have to be at least 37 feet high.

DAM I.

Average height	feet	24
Length	do	1,285
Dam of crib-work, width at base	do	60
Timber, 4,200,000 feet B. M., at $15 per M		$63,000
Rock filling, 32,450 cubic yards, at $1		32,450
Iron fastenings, 116,000 pounds, at 3 cents		3,480
Total		98,930

LOCK I.

Height of walls	feet	33
Chamber	do	300 by 60
17,000 cubic yards of masonry, at $15		$255,000
Gates and accessories		9,000
Guide-cribs and shore revetment		50,000
Total		314,000

DAM II.

Height of dam	feet	22
Length	do	1,130
(Dam similar to Dam I.)		
Timber, 3,390,000 feet B. M., at $15 per M		$50,850
Rock filling, 29,400 cubic yards, at $1.25		36,750
Iron fastenings, 114,000 pounds, at 3 cents		3,420
Total		91,020

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LOCK II.

(Height of lock-walls of Lock II, 37 feet. Other dimensions, same as of Lock I.)

21,250 cubic yards of masonry, at $15	$318,750
Gates and accessories	11,000
Guide-cribs and shore revetment	50,000
Total	379,750

SUMMATION.

	Cost.
Dam I	$98,930
Lock I	314,000
Dam II	91,020
Lock II	379,750
Total	883,700

The above estimates, I think, may be somewhat modified when determined from the complete maps.

The targets drawn on the profile indicate miles from the head of Colbert Shoals.

Very respectfully, your obedient servant,

H. E. WATERMAN,
Lieut. of Engineers.

Lieut. Col. J. W. BARLOW,
Corps of Engineers, U. S. A.

B B 2.

IMPROVEMENT OF FRENCH BROAD RIVER, TENNESSEE.

This stream rises in North Carolina, on the western slopes of the Blue Ridge, crosses the Tennessee State line at Paint Rock, and, after a course of about 121 miles in that State, unites with the Holston River, forming the Tennessee, 4½ miles above Knoxville.

When examined in 1875, the river was found to be impeded by rock and gravel shoals, drift, bowlders, etc.

The present plan consists in removing surface obstructions, building rubble wing-dams, where necessary, in order to obtain a channel sufficient to pass steamboats drawing not more than 2½ feet during the low-water season from Leadvale to mouth of river, about 90 miles.

From Leadvale to the State line, about 31 miles, the river is not susceptible of improvement without the use of locks and dams. As the present and prospective commerce of this river does not justify the heavy expenditure incident to slackwater navigation, no estimate has been submitted for any work in Tennessee above the mouth of the Nolichuky River (Leadvale).

The appropriation of August 5, 1886, became available at too late a date for use in channel-work until near the close of the fiscal year.

As a matter of economy in outlay for boats, supervision, etc., active operations are carried on in connection with the work on the Upper Tennessee and its other tributaries.

A snag and tow boat is in process of construction at Chattanooga, to be employed, when necessary, upon these streams.

The flat-boats of all kinds pertaining to the work were practically worn out and worthless, and new boats were built and put in readiness, to be used as soon as the water reached a sufficiently low stage.

Work was begun in June by repairing the dams at Fain's Island.

The commerce and navigation of the French Broad River, in Tennessee, when work was begun in 1880, was limited, and no trustworthy

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data are attainable as to its extent; but it has materially increased, and consists principally of logs, lumber rafts, and flat-boats laden with grain, live stock, forage, and other miscellaneous products and merchandise. Marble also is fast becoming an important item of shipment from recently-opened quarries.

The prospective advantages to navigation, as well as present benefits to the community, by continuing the improvement to completion, are the obtaining of an open navigable channel about 30 inches deep at low water, for the passage of rafts and flat-boats, and steamboats of light draught, as high as Leadvale, thereby facilitating the transportation of the products of a rich agricultural and mining region to a market at a reasonable cost.

The funds available and the appropriation herein asked for can be profitably expended in continuing the work of removing surface obstructions, reducing reefs, and building wing-dams, where most needed by the commerce to be benefited.

The estimate of cost of improving French Broad River, Tennessee, from Leadvale to mouth of river	$150,000.00
Amount appropriated	28,000.00
Amount expended	23,272.60

Money statement.

July 1, 1886, amount available		$129.80
Amount appropriated by act approved August 5, 1886		6,000.00
		6,129.80
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$977.25	
July 1, 1887, outstanding liabilities	425.15	
		1,402.40
July 1, 1887, amount available		4,727.40
Amount (estimated) required for completion of existing project		122,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

From July 1, 1886, to June 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Live stock ..... head..	325	Shingles ..... M..	440,000
Leaf tobacco ..... pounds..	50,000	Wood ..... cords..	6,676
Logs ..... feet, B. M..	3,390,000	Marble ..... cubic yards..	10,965
Lumber ..... do....	4,567,000	Sand ..... do....	14,305
Grain ..... bushels..	312,000	General merchandise ..... pounds..	6,921,500
Hay and straw ..... tons.	550		

BB 3.

IMPROVEMENT OF LITTLE TENNESSEE RIVER, TENNESSEE.

This stream rises in the Blue Ridge, near Rabun's Gap, Georgia, and has a northwesterly course of about 134 miles, and discharges into the Tennessee River about 47 miles below Knoxville.

An examination was made in 1882 below the mouth of the Tellico River, a distance of about 13 miles.

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The obstructions are those usually found in mountain streams—snags, bowlders, reefs, etc.

The plan of improvement adopted was to remove surface obstructions and build wing dams, where necessary, to contract the water-way, so as to secure a navigable low-water channel, 40 feet wide and 2 feet deep, below the mouth of Tellico River.

No work has been done on this river since December, 1883. Only one appropriation, that of act of August 2, 1882, $5,000, has been made for this work, which was expended to advantage.

The commerce of this river consists principally of logs, grain, and general merchandise, and is increasing.

It is very difficult to get a reliable data of this commerce, which is widely scattered along the Tennessee.

The table of "commercial statistics" herewith is, however, correct, being collected under the direction of the engineer officer in charge.

The prospective advantages as well as present benefits to navigation by continuing the proposed improvement to completion, are the securing of a safe navigable channel for rafts and flat-boats, and for the light draught steamboats plying in the Upper Tennessee; the lengthening of the season of navigation, and the diminishing of danger of passage during the "tides" caused by sudden rains; and as the river forms the principal highway for the products of the rich agricultural and mineral country through which it passes, these interests would be greatly developed and extended by the opening up of an improved channel for a safe and economical line of transit to the business centers on the Tennessee.

The appropriation herein asked for can be profitably expended in removing surface obstructions and building wing-dams, as projected.

ESTIMATE FOR IMPROVING LITTLE TENNESSEE RIVER, TENNESSEE.

Below mouth of Tellico River	$23,724
Amount appropriated	5,000
Amount expended	5,000

Money statement.

Amount (estimated) required for completion of existing project	$18,724.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

From July 1, 1886, to June 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels..	79,172	Logs ..... feet, B. M..	2,995,000
Lumber ..... feet, B. M..	204,700	Merchandise ..... pounds..	667,452

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BB 4.

IMPROVEMENT OF HIAWASSEE RIVER, TENNESSEE.

This stream rises on the western slope of the Blue Ridge in Georgia. Its course of about 135 miles is nearly at right angles to that of the Tennessee River, which it enters at a point nearly equidistant from the mouth of the Clinch River and Chattanooga, Tenn.

The head of navigation is stated to be at Savannah Ford, about 33 miles from mouth of the river, but a good channel exists from the ford to Columbus, Tenn., a few miles above.

The present project of improvement is based upon an examination made in 1874, the estimates then submitted being increased in 1885.

The obstructions are those usually found in mountain streams—rocky reefs, gravel-bars, snags, overhanging trees, etc., and the present plan is to reduce the reefs and bars, remove the other surface obstructions, and build wing-dams where deemed necessary, so as to secure a safe, navigable channel, 40 feet wide and 2 feet deep at natural low water, as far as Savannah Ford or Columbus, Tenn. Channel work was renewed late in August, under the local charge of Superintendent R. R. Thacher, and carried on until December, when operations were suspended for the winter months.

A small force in March removed some overhanging trees and repaired the dam at Magill's Island.

The following work was done during the year at Matthew's Shoals, Canefield Reef, Bunker Hill Shoals, and Magill's Island:

Clearing channel:		
Solid rock excavated	cubic yards..	16
Loose rock	do....	58
Sand and gravel	do....	48
Snags taken out	number..	17
Overhanging trees cut down	do....	28
Drift removed	cords..	42
Building dams:		
Stripping quarry	cubic yards..	162
Stone quarried	do....	483
Riprap dams	do....	630

The commerce of this river, consisting chiefly of grain, other agricultural products, and general merchandise, is carried on in flat and keel boats from the upper waters, and by small steamers plying between Charleston and points on the Tennessee River. The commerce and navigation of the Hiawassee River when work was begun in 1877 was very limited and no data is attainable of the amount.

The prospective advantages to navigation, as well as present benefits to the community by continuing the improvement to completion, are the maintenance of a clear, navigable channel, at ordinary stages of the water, for steamboats of light draught to Charleston, and for flat-boats as high up as Columbus, Tenn.

The bridge of the East Tennessee, Virginia, and Georgia Railway crosses the river at Charleston. This structure has no draw, and was built so low that when the river is at a good boating stage even the smallest steamboats plying in these waters are unable to pass through its spans; therefore, above Charleston the work would be confined to assisting the passage of rafts and flat-boat navigation. The appropriation herein asked for can be profitably expended in removing surface obstructions and building wing-dams to improve the water-way, as originally projected. The nature of the stream is such that a small au-

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nual outlay will be necessary to preserve and maintain the improved channel by removing the snags, etc., which come down during the flood-seasons.

The original estimate of cost of improving Hiawassee River, Tennessee, was	$20,000
Increased in 1885 to	36,500
Amount appropriated	34,000
Amount expended	34,000

Money statement.

July 1, 1886, amount available		$1,132.28
Amount appropriated by act approved August 5, 1886		2,500.00
		3,632.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,506.55	
July 1, 1887, outstanding liabilities	125.73	
		3,632.28
Amount (estimated) required for completion of existing project		2,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		2,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

From July 1, 1886, *to June* 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Grain.....bushels..	155,300	Logs.....feet, B. M..	500,000
Live stock.....head..	312	Merchandise.....pounds..	466,000
Hay.....tons..	360		

B B 5.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch rises in the Cumberland Mountains, in southwestern Virginia, and after a course of about 395 miles, enters the Tennessee River at Kingston, Tenn.

Only its improvement in Tennessee, about 230 miles, has been heretofore provided for in the appropriations from 1880 to 1886, inclusive.

The examination made in 1875 forms the basis of the present project of improvement, which consists in the removal of ledges, rock-points, gravel-bars, bowlders, snags, and overhanging trees, the obstructions common to all the mountain streams tributary to the Tennessee River, and building riprap dams, so as to obtain at ordinary low water a channel depth of 2 feet from the mouth of the river to Clinton, about 70 miles, and 1½ feet from Clinton to Haynes or Walker's Ferry, about 75 miles further.

From Walker's Ferry to the Tennessee State line, 85 miles, the only work that can be done to advantage is to reduce the ledges and remove the loose rock, etc., sufficiently to assist flat-boat navigation during the so-called "rain-tides."

The State of Tennessee in 1830, 1842, and subsequent years, made appropriations for improving the channel of her navigable rivers in

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East Tennessee—among these being the Clinch River; the amounts were expended in removing surface obstructions, but with little permanent beneficial result.

No work was done during the fiscal year except the care of engineer property, as the appropriation of August 5, 1886, became available at too late a date for use in channel-work.

Active operations on the Clinch River are, as a measure of economy, carried on in connection with the work on the Upper Tennessee and its other tributaries.

A snag and tow-boat is building at Chattanooga, to be used upon these streams and also upon the Lower Tennessee, as may be most advantageous and economical to the several works in question.

Flat-boats have been procured and a working force organized for the immediate resumption of channel-work at Cloud's Shoals in July, and at other points where most urgently needed, which work is now satisfactorily progressing.

The commerce and navigation of the Clinch River in Tennessee, when work was begun in 1880, was limited, and no reliable data can be found as to its then extent. Since that time the commerce has rapidly increased, year by year, the river forming the highway most available for reaching a market, there being no railroad accessible to the farming and lumber interests of its upper waters.

No specific data could be obtained of the commerce during the fiscal year, other than of one item, logs, reaching one point, a trustworthy report stating that at least 17,000,000 feet, B. M., logs in rafts were drifted to Chattanooga from the Clinch.

In this connection attention is called to the fact that the report of the commerce of the Tennessee River, "above Chattanooga," is largely made up necessarily of the aggregated shipments from the Clinch, French Broad, Holston, Hiawassee, Little Tennessee, and other tributaries.

Large quantities of grain, lumber, and stock are brought down these streams on the "rain-tides"—sudden rises—in flat-boats manned by the owners of the freight, who dispose of their shipments, boats and merchandise, to the best advantage anywhere along the route, and return to the upper waters without leaving any record available as accurate "commercial statistics."

It is this tributary commerce along these minor water highways that increase so markedly the heavy commerce of the main streams, where the data that can be obtained is generally collected and credited. (See Report of Chief of Engineers, 1883, 1884, and 1885.)

The prospective advantages to navigation, as well as present benefits to the community along its course, by continuing the improvement to completion, are the lengthening of the season of navigation, when logs and flat-boats can be safely run from the upper waters to a market at Chattanooga and intermediate points on the lower Clinch and Upper Tennessee, as well as securing a channel at ordinary low water of 2 feet depth from Kingston to Clinton, and of 1½ feet depth from Clinton to Walker's Ferry.

The work done is practically permanent, and the results of the work have given very decided satisfaction to the upper river men, who are the most interested in securing a reduction of the obstructions, thus providing additional safety to their persons and property, and consequent benefit to the merchants and traders on the lower waters, by an increase of quantity of material and decrease of cost of transportation.

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The funds available and the amount herein asked for can be profitably expended in clearing, widening, and deepening the channel between Walker's Ferry and mouth of the river in accordance with the existing project.

The original estimate for improving Clinch River in Tennessee was	$26,400.00
Increased in 1885 to	50,000.00
Amount appropriated	26,000.00
Amount expended	21,574.10

Money statement.

July 1, 1886, amount available		$36.57
Amount appropriated by act approved August 5, 1886		5,000.00
		5,036.57
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$265.89	
July 1, 1887, outstanding liabilities	344.78	
		610.67
July 1, 1887, amount available		4,425.90
Amount (estimated) required for completion of existing project		24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		24,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

B B 6.

IMPROVEMENT OF DUCK RIVER, TENNESSEE.

This stream is wholly in the State of Tennessee. It rises in the plateau of the barrens, near the center of the State, and after a course of about 250 miles enters the Tennessee River 14½ miles above Johnsonville.

An examination was made in 1879 to Centerville, about 68 miles.

The obstructions were found to be gravel-bars, rock-ridges, and numerous snags and overhanging trees.

The plan adopted when work was begun, in 1880, was to remove surface obstructions and build wing-dams, so as to secure 3 feet of water during the season of navigation—from four to six months of each year.

No work has been done since 1883, and each annual report since has stated that the river is "in a fair navigable condition from Centerville to its mouth, and will probably answer for the present needs of commerce." No examination of the stream has been made since operations were suspended, but from the character of the stream it may safely be stated that a small annual outlay will be necessary to maintain the advantage gained by the work already done, by removing snags, drift, etc., that accumulate rapidly, being brought down during the flood season.

The commerce of the Duck River consists principally of corn, peanuts, logs, and general merchandise. It was not practicable to obtain data.

The amount herein asked for can be profitably expended in carrying on the work as originally projected, if Congress deems it advisable to complete the improvement.

Estimate for improving Duck River, Tennessee	$35,118
Amount appropriated	13,000
Amount expended	13,000

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Money statement.

Amount (estimated) required for completion of existing project.....	$22,118.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867	

BB 7.

IMPROVEMENT OF CUMBERLAND RIVER.

This stream rises on the west slope of the Cumberland Mountains, in Kentucky, and after a winding course of about 700 miles enters the Ohio about 73 miles above the mouth of that river.

Its improvement was undertaken by the States of Kentucky and Tennessee, together with other streams within their borders, in 1830 and subsequent years.

In 1870 Congress authorized a survey of the river from the head of navigation to its mouth, and upon this survey or examination is based the present project for the improvement of the river below Nashville, and the project for the work done above Nashville to foot of Smith's Shoals, from 1876 to the adoption of the existing project by Congress.

The work done on the Smith's Shoals above Burnside, from 1876, was based upon survey and estimates made in 1875 and modified in 1879. A reconnaissance of the Upper Cumberland, above the falls, was made in 1880.

The obstructions found are of the same general character throughout its course, consisting of rock ledges, gravel-bars, bowlders, snags, overhanging trees, and rapid currents, and of mill-dams in the section above the mouth of the Jellico River, Kentucky.

Congress made five appropriations from 1832 to 1838 for this improvement, aggregating the sum of $155,000, of which $20,000 was to be applied "below Nashville" and $135,000 for the river generally.

No further appropriations were made until 1871, since which time $656,000 have been made available for expenditure upon the several sections as specified and provided for by the twelve acts making the appropriations.

(1) *Below Nashville, 192 miles.*—This section of the river is navigable from Nashville to the mouth of the river for all steamboats plying upon it for six months in each year, and for boats drawing not more than 3 feet, from six to eight months; and for boats of about 16 inches draught the entire year.

The appropriation of August 5, 1886, was made available at too late a date to take advantage of the low-water season of that year.

In May the work of making the necessary repairs of the boats at the mouth of Mill Creek was begun, and in June a working party moved down the river, clearing the channel from Nashville to Robinson's Island, about 12 miles, taking out 26 snags and stumps and cutting down 15 overhanging trees; the work in the channel is now satisfactorily progressing with a force of about 50 men.

An improved channel with a lengthened season of navigation has been secured on this section.

The commerce below Nashville, when the improvement began in 1871, consisted largely of corn, tobacco, lumber, etc., but it is not pos-

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sible now to give any data that would be more correct and definite than those already embraced in the reports of the Chief of Engineers (1871, *et. seq*).

The "commercial statistics" herewith embrace the period of the last eighteen months, and show a largely increasing trade.

So far as ascertained the work thus far executed has had no appreciable effect upon the rates of insurance, and the rates of freight are controlled by the competing steamboats plying upon the river.

A new line of steamers has been put in operation during the year, with headquarters at Clarksville, Tenn.

From 1832 to the present time the work done below Nashville has been simply to clear the channel of surface obstructions; to improve from time to time some of the worst shoals, and thus to secure safety to the life and property afloat during a lengthened season of navigation; but as Congress has already provided for a radical improvement of the river above Nashville by a system of locks and dams, beginning with a lock at the Lower Nashville Island, it may reasonably be anticipated that the section below Nashville will ultimately form a part of a complete system of canalization, to the advantage of navigation and the general interests of the Lower Cumberland; the river forming the highway, and in many cases the only means of transit for persons and property, between the villages and towns scattered along its lower course.

An instrumental survey of the river below Nashville, similar to that made in 1883 above Nashville, is very desirable, and should be made without delay; not alone to obtain data in view of a possible extension of the lock and dam system, but to secure a profile of the river with detail maps, etc., of the obstructions, so that systematic operations may continue to be carried on under the existing project, in the manner most economical and advantageous to the Government and the work.

The funds available and the amount herein asked for can be profitably expended in continuing the work of snagging, removing loose rock, etc., from the channel and in improving the shoals at Palmyra Island, Dover Island, Gatlin Island, Line Island, and other points, including channel at mouth of the river. Also, if approved, in making an instrumental survey, with profile of river, detail maps, etc., as hereinbefore suggested.

The original estimate of cost of improving the Cumberland River below Nashville	$248,821.00
Estimate increased in 1884 to	348,000.00
Amount appropriated	255,000.00
Amount expended	243,649.34

Money statement.

July 1, 1886, amount available		$140.74
Amount appropriated by act approved August 5, 1886		12,500.00
		12,640.74
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$312.28	
July 1, 1887, outstanding liabilities	977.80	
		1,290.08
July 1, 1887, amount available		11,350.66

Amount (estimated) required for completion of existing project	93,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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(II) *Above Nashville, 335 miles.—From Nashville to head of Smith's Shoals.*—Above Nashville the river is navigable to Point Burnside, Ky., a distance of 327 miles, for steamboats drawing not more than 3 feet, from four to six months of each year, and for boats of larger draught, from two to three months.

From Nashville to Carthage, Tenn., the mouth of Caney Fork River, 118 miles, the river is navigable from six to eight months for steamers of 2½-feet draught, and for four or five months for larger boats.

The present project is based upon a survey made and estimate submitted in 1883, which provide for a complete system of locks and dams to the head of Smith's Shoals.

Congress, by the act of August 5, 1886, provides for beginning this work by appropriating for a lock and dam at or near Lower Nashville Island.

A thorough examination of the river-bed and banks in the vicinity designated, with a view to selecting a suitable lock-site, was made; also, careful examinations of the rock formations were made from Hartsville Ferry, 87 miles above Nashville, to Clarksville, 58 miles below Nashville, for rock suitable for dimension stone for the proposed lock.

Mr. C. A. Locke, the assistant engineer in local charge, reports that a ledge was found near the proposed lock-site, and another 15 miles below it, each of which appears well suited for lock masonry.

In January a map of the proposed lock-site and plan and cross section of proposed lock and dam, the lock to be 250 feet long between miter-sills, and 50 feet wide, and to have an extreme lift of 12 feet, were submitted to the Chief of Engineers. These dimensions appear to be amply sufficient to satisfy the steamboat interests and the demands of navigation, and a lock of larger size would have only the appreciable effect of increasing the cost and consequent delay, if appropriations of the usual amount only are made available.

In the project approved by act of July 5, 1884 (Ex. Doc. 128, Senate, Forty-eighth Congress, first session), it is stated that the [locks] "should be about 60 feet wide, and 250 feet between miter-sills, though perhaps smaller dimensions would answer the purpose."

A board of engineer officers was convened in March to examine and report upon the location and dimensions of the proposed lock.

A majority of the board recommended a lock 280 feet long and 52 feet wide.

Upon the location and lift of the proposed lock the board were unanimous.

The report of the board has received the approval of the Chief of Engineers and Secretary of War.

Additional examination of the proposed site was thus rendered necessary, and plans and estimates are being prepared for a lock of the dimensions recommended by the board.

In order that work might be begun and carried on upon the proposed site at the earliest day practicable, application was made to the legislature of the State of Tennessee for "an act to give consent to the purchase by the United States of such lands as may be required for sites for lock and dams, etc., at or near the lower island at Nashville, and to grant cession of jurisdiction over said lands."

Such an act was approved by the governor March 22, 1887.

If the land required be donated to the United States, as has been suggested by those in interest, it is not readily seen why, after the title has been approved by the Honorable the Attorney General, work must of necessity be delayed for the legislation necessary in the case of a purchase

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in which the payment by the United States of a pecuniary consideration is involved.

The following work was also done from July to November, in the channel, etc., at the obstructions named, securing at the foot of Forbush Shoals a deepening of the channel by several feet, and at Smith's Shoals a reduced velocity of the current, giving additional security in the passage of coal-boats, etc.

Location.	Excavation.		Embankment.	Quarrying rip-rap stone.	Dams built.	Drift removed.	Trees cut down.
	Solid rock.	Loose rock.					
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cords.*	
Smith's Shoals	133	105	.....	.....	8	12	4
Forbush Shoals	.....	1,440	1,385	.....	.....	.....	.....
Priestly's Shoals	.....	.....	.....	1,072	.....	.....	.....
Total	133	1,545	1,385	1,072	8	12	4

The commerce of the upper Cumberland is shown by the accompanying statements, and is largely increasing.

The prospective advantages to the commerce, as well as present benefits to the community, are the extension of the lower river trade as fast as the locks can be completed and utilized; and for the upper section the opening up of a cheap and safe means of transportation for the almost unlimited mineral resources of the Upper Cumberland Valley.

As stated in the last annual report, it might seem proper to take into consideration the fact that the section of the river from Burnside to the Kentucky State line has claims for immediate improvement quite as great as those on the portion directly above Nashville.

The facilities for carrying on the improvement from Point Burnside are equal if not superior to those at Nashville. Stone for locks, of excellent quality, can be found near at hand, while all other supplies, especially iron, can be obtained via Cincinnati rapidly and at the lowest possible cost.

These considerations lead to the suggestion that it may be advisable to subdivide the "Cumberland River above Nashville" from Nashville to head of Smith's Shoals, Kentucky, and the appropriations for its improvement into three sections:

(1) In Tennessee, above Nashville.
(2) In Kentucky, below Point Burnside.
(3) At Smith's Shoals.

Estimate for improving Cumberland River from Nashville to head of Smith's Shoals		$4,077,922.00
Amount appropriated		125,000.00
Amount expended		47,388.81

Money statement.

July 1, 1886, amount available		$10,398.25
Amount appropriated by act approved August 5, 1886		75,000.00
		85,398.25
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,474.83	
July 1, 1887, outstanding liabilities	312.23	
		7,787.06
July 1, 1887, amount available		77,611.19

Amount (estimated) required for completion of existing project	3,952,922.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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(III). *Cumberland River above mouth of Jellico, Kentucky, 110 miles.*—This section was examined in 1880, and an estimate submitted for its improvement to Cumberland Ford (Pineville), the project being to give safe navigation for about four months in the year.

An appropriation of $10,000 was made for this section in 1881, and in the following year $5,000 was added, and this appropriation (1882) remains in the Treasury.

The chief obstructions are gravel-bars, snags, and 11 mill-dams.

Until the dams are bought, either by voluntary agreement or by condemnation, it appears to be impracticable to do any further work on this section.

A descriptive list of these dams is given in the Annual Report of the Chief of Engineers, 1883, pages 1491, 1492.

In September, 1886, a circular letter was sent to each of the owners of the dams, asking for the lowest price at which the dam would be sold, vesting a good title in the United States.

Replies were received from nine of the eleven owners.

The estimated values as given in the Report of 1883 equal $15,250.

The lowest price asked in 1886 for the 9 dams was $15,710, to which add the estimated value of Dams Nos. 6 and 9, no reply having been received, $1,350, making a probable voluntary valuation of $17,060, which appears to be reasonable.

The charter granted by the State of Kentucky, April 24, 1882, to the Cumberland River Improvement Company to build locks and dams, condemn mills, collect tolls, etc., referred to in Report of Chief of Engineers, 1884, page 1649, was repealed by act approved January 24, 1884.

Should Congress not determine to continue the improvement by the necessary legislation, having in view the voluntary purchase or condemnation of these mill-dams, I would respectfully recommend that the balance be made available for expenditure upon the "Cumberland River above Nashville."

Estimate for improving the Cumberland River above the mouth of Jellico, Kentucky	$50,000
Amount appropriated	15,000
Amount expended	10,000

Money statement.

July 1, 1886, amount available	$5,000
July 1, 1887, amount available	5,000
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000

COMMERCIAL STATISTICS.

Cumberland River below Nashville, from January 1, 1886, to June 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Brick ..... number..	93,850	Salt ..... barrels..	11,499
Coal ..... tons..	1,108	Tobacco ..... pounds..	21,371,200
Cotton ..... bales..	595	Wood ..... cords..	9,415
Flour ..... barrels..	17,227	Lumber ..... feet B. M..	5,178,864
Grain ..... bushels..	2,020,472	Logs ..... do ..	2,580,000
Hay ..... tons..	952	Shingles ..... M..	5,007,500
Iron ..... do....	10,309	General merchandise ..... pounds..	32,128,482
Live stock ..... head..	2,434	Passengers ..... number..	33,828

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List of steamboats plying on Cumberland River below Nashville.

Names of boats.	Tonnage.	Names of boats.	Tonnage.
B. S. Rhea	203	T. Shiver	127
J. P. Drouillard	467	Julian Gracy	81
W. H. Cherry	396	J. H. Hillman	281
City of Nashville	194	James R. Skiles	41
City of Clarksville	194		

COMMERCIAL STATISTICS.

Cumberland River above Nashville, from January 1, 1886, to June 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Brick.....number..	40,700	Sand.....cu. yds..	26,670
Coal.....tons..	10,785	Tobacco.....pounds..	14,872,428
Cotton.....bales..	4	Wood.....cords..	1,589
Flour.....barrels..	11,798	Lumber.....feet B. M..	40,972,672
Grain.....bushels..	909,294	Logs.....do....	46,860,000
Hay.....tons..	93	Shingles.....M..	189,000
Iron.....do....	22	General merchandise.....pounds..	18,632,226
Live stock.....head..	6,435	Passengers.....number..	26,224
Salt.....barrels..	10,466		

List of steamboats plying on Cumberland River above Nashville.

Names of boats.	Tonnage.	Names of boats.	Tonnage.
H. K. Bedford	139	Crusader	188
Sam P. Jones	359	J. D. Carter	45
Wm. Porter	168	Lucy Robertson	81
John Fowler	237	Pearl	31
Matt F. Allen	245		

CONDITION OF THE CUMBERLAND RIVER ABOVE THE MOUTH OF THE JELLICO, IN KENTUCKY.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., January 27, 1887.

GENERAL: In compliance with the requirements of the river and harbor bill, approved July 5, 1884, and the instructions contained in letter of Chief of Engineers dated February 26, 1886, I have the honor to submit the following report upon "the condition of * * * the Cumberland River above the mouth of the Jellico, in Kentucky, and the provisions and estimates necessary to relieve the same from incumbrance, with a view to such legislation as will render the same free to commerce at the earliest practicable period:"

A preliminary report was made by Maj. W. R. King, Corps of Engineers, in October, 1884 (Appendix B B 12, Report Chief of Engineers, 1885), in which it was suggested that the data required were simply *estimates* of the cost of buying the dams by voluntary agreement, and the conditions of the repeal of a certain charter granting franchises and privileges to the Cumberland River Improvement Company.

The Chief of Engineers having instructed Major King to obtain the information, etc., "suggested as advisable in your (his) preliminary re-

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port," that officer, upon being relieved, transferred the report upon this matter as unfinished business.

Upon application to the secretary of state of Kentucky, that officer has furnished me with a copy of the act approved January 24, 1884, to repeal an act to incorporate the Cumberland River Improvement Company, approved April 24, 1882, properly authenticated under seal, which copy is herewith transmitted (Appendix A).

On September 24, 1886, circular letters were sent to the owners of the eleven obstructive dams, asking that the owner or owners of each dam would send me a statement of the *lowest price* for which they would sell the mill-dam in question and vest a good title to the same in the United States.

Replies have been received from nine of the owners, some having whole and others undivided interests; the other two were written to a second time, but no answers have been received.

The owners appear to be reasonable in their demands, as will be seen from a comparison of the estimated money value in 1883, many repairs, some extensions, etc., so stated, having been made *ad interim* to the dams:

Dams.	Estimated value in 1883.*	Lowest price asked, 1886.
No. 1	$1,000	$2,000
No. 2	3,700	4,000
No. 3	500	600
No. 4	3,600	4,000
No. 5†	1,000	2,000
No. 6	150	‡ 150
No. 7	1,500	1,000
No. 8	1,500	1,000
No. 9	1,200	‡ 1,200
No. 10	300	610
No. 11	800	500
Total value (estimated)		17,060

* See Report Chief of Engineers, 1883, Appendix Y 2.
† Minor heirs, undivided estate.
‡ No answer received.

In this connection, and having special reference to these dams as obstructions, attention is invited to Report of Chief of Engineers, 1886, Improving the Cumberland River, Appendix Z 2.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

A.

CHAPTER 52.—An act to repeal an act entitled "An act to incorporate the Cumberland River Improvement Company," approved April 24, 1882.

Be it enacted by the general assembly of the Commonwealth of Kentucky.

SECTION 1. That an act entitled "An act to incorporate the Cumberland River Improvement Company," approved April twenty-fourth, eighteen hundred and eighty-two, be, and the same is hereby, repealed.

SEC. 2. This act shall take effect from and after its passage.

CHAS. OFFUTT,
Speaker of the House of Representatives.
JAMES R. HINDMAN,
Speaker of the Senate.

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COMMONWEALTH OF KENTUCKY,
Office of Secretary of State:

I, J. A. McKenzie, secretary of State for the Commonwealth aforesaid, do hereby certify that the foregoing writing has been carefully compared by me with the original on file in this office, whereof it purports to be a copy, and that it is a true and exact copy of the same.

In testimony whereof I hereto sign my name and cause my official seal to be affixed. Done at Frankfort this 27th day of September, A. D. 1886.

[SEAL.]

J. A. MCKENZIE,
Secretary of State,
By H. M. MCCARTY,
Assistant Secretary of State.

B B 8.

IMPROVEMENT OF SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

This stream is formed by the junction of New River and Clear Fork, in Tennessee, and after a northerly course of about 88 miles enters the Cumberland River at Point Burnside, Ky.

The present plan is based upon an examination made in 1881, when the obstructions were found to be principally large bowlders and rock-reefs, and at present provides only for the improvement of the river below the "Devil's Jumps," a distance of about 44 miles. Above this formidable barrier to the Kentucky State line, about 8¾ miles, the river runs through a wild cañon, with its narrow channel obstructed by immense sandstone bowlders, the fall being too great for safe navigation, even if the channel were improved by a reduction of the surface obstructions.

In October, as soon as practicable after the appropriation of 1886 was made available, active operations were resumed at Sloan's Shoals and Roberts's Mill Shoals, which were continued until January, when work was necessarily suspended for the winter months; it was again started at Sloan's Shoals in the last month of the fiscal year and is now progressing at that point, and will be continued to the extent of the small amount of funds available.

Location.	Excavation.		Quarrying riprap stone.	Dams built.
	Solid rock.	Loose rock		
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Sloan's Shoals	80	230	412	1,499
Roberts's Mill Shoals	150	353	.....	567
Total	230	583	412	2,066

The commerce of this stream consists principally of logs in rafts, but it is very difficult to get any data pertaining to the rafting, lumber, or coal interests of sufficient definiteness to be classed as "commercial statistics."

Work was begun on this river in 1881, and has resulted in improving the water-way by clearing and deepening the channel to a limited extent in the lower river. Much work remains to be done, and the prospective as well as present advantages to those living on its borders by continuing the work as projected are the obtaining of a good, navigable channel for rafts, and also for the coal that can be readily

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mined from the coal measures through which the river passes, as soon as sufficient improvement is effected to practically secure a safe passage for flat-boats to the Cumberland River during the so-called "rain-tides," or rises of about 3 feet.

The amount available and the appropriation herein asked for can be profitably expended in continuing the work below the "Devil's Jumps," by reducing rock-reefs and bowlders, and building wing-dams where necessary.

ESTIMATES FOR IMPROVING SOUTH FORK OF CUMBERLAND RIVER, KENTUCKY.

From Kentucky line to "Devil's Jumps"	$27,538.00
From "Devil's Jumps" to mouth of South Fork	35,265.00
	62,803.00
Amount appropriated	12,000.00
Amount expended	10,122.64

Money statement.

July 1, 1886, amount available		$132.70
Amount appropriated by act approved August 5, 1886		5,000.00
		5,132.70
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,087.70	
July 1, 1887, outstanding liabilities	167.64	
		3,255.34
July 1, 1887, amount available		1,877.36
Amount (estimated) required for completion of existing project		50,803.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

From July 1, 1886, *to June* 30, 1887.

Articles.	Quantities.
Logs.....feet, B. M..	8,656,970
Coal.....tons..	300

B B 9.

IMPROVEMENT OF CANEY FORK RIVER, TENNESSEE.

This stream rises in the Cumberland Mountains, near Sparta, Tenn., and after a northerly course of about 200 miles, wholly in the State of Tennessee, discharges its waters into the Cumberland River, about 120 miles above Nashville, at Carthage, Tenn.

The head of navigation is usually held to be at Sligo, Tenn., about 72 miles from the mouth of the river.

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An examination was made of the Caney Fork in 1879, from Sligo to its mouth, and a report submitted upon which the present project is based. Under the provisions of the river and harbor act of July 5, 1884, an extension of the examination of 1879 was made in September, 1886, to Frank's Ferry, about 20 miles above Sligo.

These examinations show that the principal obstructions in the 92 miles are similar in character, and consist of gravel-bars, crooked channel, snags, and overhanging trees.

The present plan is to remove the channel obstructions and build the necessary wing-dams and training-walls so as to obtain sufficient water for safe navigation of steamboats of not more than 3 feet draught, from February to June, the usual boating season.

No work was done in the channel during the fiscal year, as the appropriation of 1886 became available at too late a date for advantage to be taken of the low-water season of that year. As soon as the weather and stage of water permitted, flat-boats were built and a force organized, which is now working down-stream from Sligo's Ferry, removing snags and overhanging trees, building dams, etc., with good success.

The commerce and navigation of the Caney Fork River when work was begun, in 1880, was considerable, for the river channel was the highway through which the people of that section of the State sent their produce to market and received their general merchandise supplies; and each year since the commerce has been growing larger.

The prospective advantages as well as present benefits to navigation, by continuing the improvement to completion, are the securing of a safe, navigable channel for rafts, flat-boats, and light-draught steamboats from Frank's Ferry to the mouth of the river.

The extension of the work of improvement as high as Frank's Ferry is recommended because this stream is the principal means of transportation, and up-stream navigation can readily reach Frank's Ferry when Sligo can be reached from the Cumberland River.

The table of "commercial statistics" herewith is not estimated; the quantities so far as given are correct, but it by no means represents the entire commerce of the stream, it being impossible to obtain a record of all shipments and flat boat freights; no statement of log-rafts could be obtained, though a great many logs unquestionably reached the Nashville mills from this stream.

A list of light-draught boats that ply up and down the Caney Fork and Cumberland rivers during the boating season is also appended.

The funds available and the amount asked for can be profitably expended in continuing and extending the work as herein projected.

The character of this stream is such that a small yearly outlay will be necessary to maintain the channel in a safe condition, after the improvement is practically completed, as the snags, logs, etc., brought down by the annual floods should be promptly removed.

ESTIMATES FOR IMPROVING CANEY FORK RIVER, TENNESSEE.

From mouth to Sligo, Tenn	$30,228.00
From Sligo to Frank's Ferry	15,000.00
	45,228,00
Amount appropriated	20,000.00
Amount expended	17,489.02

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Money statement.

July 1, 1886, amount available		$430.72
Amount appropriated by act approved August 5, 1886		3,000.00
		3,430.72
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$171.53	
July 1, 1887, outstanding liabilities	748.21	
		919.74
July 1, 1887, amount available		2.510.98
Amount (estimated) required for completion of existing project		25,228.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

From July 1, 1886, to June 30, 1887.

Articles.	Quantities.	Articles.	Quantities.
Grain ..... bushels..	60,000	Tobacco ..... pounds..	592,200
Lumber ..... feet, B. M..	500,000	General merchandise ..... do....	532,600

List of steamboats plying on Caney Fork River.

Names of boats.	Tonnage.	Names of boats.	Tonnage.
City of Nashville	194	Matt F. Allen	245
Wm. Porter	168	John Fowler	237
H. K. Bedford	139	J. D. Carter	45
Sam. P. Jones	359		

B B 10.

EXAMINATION OF CANEY FORK RIVER, TENNESSEE.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., September 24, 1886.

GENERAL: In compliance with instructions contained in Department letter of February 26, 1886, to Maj. W. R. King, Corps of Engineers, I have the honor to present the following report upon an examination of Caney Fork River, Tennessee.

This examination was made under my direction by Assistant Engineer C. A. Locke, in August last, with a view to determining the advisability of extending the plan of improvement now in progress below Sligo, to Frank's Ferry, about 20 miles above. The results are approximate, as the fall of the stream was measured only at the various shoals, and with a pocket level; courses were taken with a compass, and distances from point to point estimated.

This section of the river in its general character is similar to the portion below Sligo, the amount of water, the width and depth being about the same, and between the shoals are quiet pools of sufficient depth for

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navigation. The fall at the various shoals is greater than below Sligo, and they occur at more frequent intervals; the cost, therefore, per mile of a radical improvement will be very much larger. The shoals are generally rock in place, frequently underlying beds of gravel and bowlders.

The length of this section of the river is about 22 miles, and has an aggregate fall of 62½ feet, or nearly 3 feet to the mile, while at some of the rapids the fall is 1 foot in 50, and artificial falls even greater exist where fish-traps have been put in.

The uplands on either side of the stream produce hard timber and poplar; many farms are under cultivation, yielding grain, fruit, and vegetables. The bottom lands, though not of great extent, are very fertile and valuable.

The river if improved would afford a much desired means of transportation for this region, as it is remote from railway facilities.

There seems to be sufficient reason to recommend the improvement of this part of the river in connection with the improvement already approved for the section from Sligo to the mouth.

A thorough improvement would consist in the removal of about 10,000 cubic yards of loose bowlders and gravel, cutting a small number of overhanging trees, and reducing the slope at the various shoals by constructing wing-dams and training-walls, as may be found necessary.

An approximate estimate of the cost of the entire work is $53,000. About $15,000 would suffice to carry the improvement to an extent which would make the river available for down-stream navigation during a rise of 5 feet, and probably for up-stream navigation also when Sligo can be reached from below.

To that extent which would include the removal of obstructing bowlders and gravel-bars, overhanging trees, and the construction of about 5,000 cubic yards of wing-dams, I would recommend the improvement to be carried.

For more full details, reference is respectfully made to the accompanying report of Assistant Engineer C. A. Locke, which contains a table of distances, the fall at the various shoals, etc.

A tracing showing the general course of the stream between Sligo and Frank's Ferry is also inclosed.

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. A. LOCKE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Nashville, Tenn., September 6, 1886.

COLONEL: In accordance with your instructions of June 14, and subsequently, on August 22, I left here for Frank's Ferry to make an examination of Caney Fork River, from that point down to Sligo.

This report is accompanied by a map intended only to give generalities. Distances are estimated; courses taken with a compass; elevations or falls at the shoals taken with a pocket level; the fall of the reaches between the shoals is estimated by the distance and a general knowledge of the fall of rivers of similar conditions; the additional fall at the numerous narrow reefs in these reaches (pools) has been added to that of the pools.

The general plan of improvement proposed applies to each shoal. It is—

1. If in the proposed channel there are any loose bowlders, irregular prominences, or old fish-trap dams they should be removed.

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2. Excavations on the shallow crests for the purpose of a general deepening at that point should be avoided as expensive and tending to produce a lower level of the pool above.

3. The water should be turned into one channel (on the shoals) of 50 or 60 feet in width by means of riprap, spur, or training dams placed on the shoals below the crest and at the shallow points entirely below the shoal to be improved, so that each will back or dam the water above it, and thus distribute and equalize the slope. Advantage should be taken of the numerous reefs and shallow places found in the pools for the placing of spur-dams to benefit the shoal above. Most of these reefs have been marked on the accompanying map; the depth given to them is at their deepest points (channel).

4. Virtually the improvement of the shoals embodies the work. No snags were found.

As no reliable data could be had of low water, I made no measurement of volumes, but estimated it at time of survey as 900 cubic feet per second. Soundings are those of probable low water.

The highest water-mark pointed out at Frank's Ferry was 27 feet above low water, while that at Sligo was 39 feet, a difference of 12 feet. These freshet-marks are probably 8 or 10 feet above ordinary high water.

From Frank's Ferry to Sink Creek the river is inclosed by steep hills (probably 350 feet high) or rock precipices. On one side there is generally a strip of rich bottom land about 200 to 400 feet wide, cultivated between the river and foot of bluff. The shoals are loose rock fragments, probably lying on rock ledges.

From Sink Creek to Floating Mill the hills are not so high, but few precipices are found; the bottom lands are often found on both sides at once, and are wider in some instances, reaching to one-third of a mile from the river. The shoals of this section are gravel (probably caught by rock ledges), and the banks being the same should be protected by slope-walling where made one side of the adopted channel. This especially applies to No. 10, Sink Creek Shoals.

From Floating Mill to Sligo the steep hills and precipices again approach the river, with large square fragments (one-half to 8 cubic yards) at their base, and some in the river. The hill on the left bank follows the meanderings of the river, while many of those on the right bank are normal to it.

I would call your attention to the number of shoals from No. 9 to Frank's Ferry and the proportional distance.

The section through which this portion of Caney Fork River flows is a farming and hard timber and poplar region.

The farm products are principally corn, oats, wheat, other small grain, and apples. Attention is being turned to hay with promise in the near future. A good many slides for putting in saw-logs, chestnut rails, and posts for the Nashville region, and the logs themselves, are seen in descending the river.

As near as I can gather, during the past season there was floated out from above Sligo 45 rafts of saw logs, averaging 125 feet long by 25 feet wide, and 40,000 feet, B. M. each, or 45 by 40,000 = 1,800,000 feet, B. M.; also 2 barges loaded with corn and fruit, each about 20 feet by 80 feet.

It is thought advisable to improve this section of Caney Fork River for the following reasons:

1. It is in a section without rail or river transportation.

2. The wagon roads are mountainous, and in winter must be impassable with commercial loads; they are not macadamized.

3. During the wet season, with its bad roads, the river would be available when most required, and when the roads were good the river would be low and not navigable.

4. The proposed improvement would probably make the river available for eight months of each year, and such seasons as that just passed longer.

5. The citizens interested think that if Caney Fork is improved to Sligo it should be to Frank's Ferry.

6. An examination of the acts of the State of Tennessee from 1824 to 1879, inclusive, show that March 14, 1860, $1,000, was appropriated for the "cleaning out of Caney Fork River," and on March 19, 1860, $1,000 was appropriated for the same in DeKalb County. The bulk of the proposed improvement just examined is in DeKalb County, or is its boundary line. If the State thought it deserving of attention there must have been merit in it.

The objections to making this improvement are:

1. Its cost per mile is materially more than the estimate given for the lower river by Mr. Turrell; and,

2. While the country tributary to this upper river is of above average fertility, it is probably not equal to the lower region in this respect. This applies to agriculture and not to forestry.

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ESTIMATE OF COST.

The following quantities are for dams of 6 feet width on top and slopes 1½ on 1. The body and lower side should be of fragments of not less than one-fifth cubical yard, and the upper slope should be caulked with the smaller fragments and spalls.

A comparison of Mr. Turrell's survey with this submitted to you will show in the latter greater and more precipitous falls than on the lower river. An effort to distribute these declivities into gentler slopes accounts for the great cost. In this connection I would say that if the cost of this plan of improvement would debar it from consideration that the rafting interests especially, as well as the boating interests, would be materially benefited by the removal of the 1,035 cubic yards of loose rock, without other improvement, and that a further improvement requiring about 5,000 cubic yards of riprap in addition to this last removal would probably open this section to the down-stream trade when the river was open below Sligo, and possibly might make it available for up-river craft when they could reach Sligo. This last-mentioned plan would probably give communication on all stages of the river at or above 5 feet above low-water mark.

Locality and nature of obstructions.	Length in feet.	Least channel depth, exclusive of the narrow reefs in the pools.	Total fall, in feet, over the preceding length.	Fall at reefs in pools. (This fall is included in preceding column.)	Cubic yards of riprap stone.	Cubic yards loose rock to be removed from channel.	Overhanging trees to be cut.
Frank's Ferry	0	.....	.....	.....	.....	.....	.....
Pool below	1,200	5.0	0.10	0.00	.....	.....	.....
Frank's Ferry Shoals, No. 1	1,200	0.4	5.00	.....	1,200	90	.....
Pool below	800	5.0	0.06	0.00	.....	.....	.....
Shoal No. 2	600	0.8	4.80	.....	1,100	60	.....
Pool below	1,400	2.0	0.23	0.15	.....	.....	.....
Salt Shoal, No. 3	300	0.7	4.50	.....	700	150	15
Pool below	7,400	4.0	0.94	0.50	.....	26	3
Three Island Shoal, No. 4	200	1.4	1.00	.....	800	90	2
Pool below	500	3.0	0.03	0.00	.....	.....	.....
Shoal No. 5	200	0.8	1.10	.....	800	10	.....
Pool below No. 5	1,000	4.0	0.06	0.00	.....	.....	.....
Saunders' Fish-trap Shoal, No. 6	40	(*)	2.00	.....	600	120	.....
Pool below	3,800	7.0	0.29	0.10	.....	.....	.....
Walker's Fish-trap, No. 7	40	(*)	2.10	.....	600	100	.....
Pool below	1,800	5.0	1.00	0.90	.....	.....	.....
Shoal No. 8	50	1.2	1.20	.....	900	20	.....
Pool below	3,100	4.0	0.45	0.30	.....	.....	.....
Slick Rock Shoal, No. 9	300	1.0	1.50	.....	900	40	.....
Pool below	18,300	4.0	2.00	1.10	.....	30	.....
Sink Creek Shoal, No. 10	500	0.8	2.50	.....	2,400	40	12
Pool below	5,200	6.0	1.60	1.30	.....	10	.....
Brain's Island Shoal, No. 11	200	1.0	1.70	.....	1,300	30	.....
Pool below	5,900	5.0	0.35	0.00	.....	.....	.....
Cowhorn Shoal, No. 12	200	2.0	2.70	.....	2,000	.....	2
Rapids below	480	2.5	1.00	.....	.....	.....	.....
Pool below rapids	14,600	5.0	2.60	1.70	.....	15	.....
Pin Hook Shoals, No. 13	500	0.8	1.40	.....	1,000	.....	.....
Pool below	7,300	4.0	0.36	.....	.....	.....	.....
Pine Creek Shoals, No. 14	400	1.8	3.20	.....	3,200	.....	.....
Pool below No. 14	18,100	4.0	2.00	1.00	.....	12	23
Self's Shoal, No. 15	500	1.3	3.00	.....	2,400	.....	.....
Rapids below	1,400	4.0	1.40	.....	.....	40	8
Pool below No. 15	500	5.0	0.00	0.00	.....	.....	.....
Love's Ferry Shoals, No. 16	300	1.0	2.10	.....	2,000	.....	.....
Pool below	6,500	5.0	2.02	1.70	.....	110	.....
Floating Mill Shoal, No. 17	400	1.1	2.30	.....	800	30	.....
Pool below	1,600	4.0	0.38	0.30	.....	12	.....
Shoal No. 18	40	2.0	0.80	.....	200	20	.....
Pool below	8,300	5.0	1.32	0.90	.....	50	.....
Shoal No. 19	300	1.3	1.30	.....	1,600	.....	.....
Sligo Ferry	1,200	4.0	0.10	.....	.....	.....	.....
	116,570	.....	62.49	9.95	24,500	1,035	65

*Artificial.

RECAPITULATION OF FALL.

	Feet.
On the shoals and rapids	46.60
On the reefs in the pools	9.95
The pools proper	5.94
Total fall in about 22 miles	62.49

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APPROXIMATE COST.

24,500 cubic yards riprap dam, at $2	$49,000
Removing 1,035 cubic yards loose stone from channel, at $3	3,105
Cutting 65 overhanging trees, at $2	130
Boats and tools	1,200
	53,435

The cost per mile if the more thorough plan of the preceding table is adopted would be $2,430 per mile.

Very respectfully, your obedient servant,

C. A. LOCKE,
Assistant Engineer.

Lieut. Col. J. W. BARLOW,
Corps of Engineers.

B B 11.

EXAMINATION OF HOLSTON RIVER, TENNESSEE.

CHATTANOOGA, TENN., *July* 9, 1887.

SIR: In compliance with the requirements of the river and harbor act approved July 5, 1884, and the instructions contained in the letter of Chief of Engineers dated February 26, 1886, I have the honor to submit the following report upon an examination of the Holston River, Tennessee.

A preliminary report was made by Major W. R. King, Corps of Engineers (App. B B 13, Report Chief of Engineers, 1885), in which that officer suggests a continuation of the examination made under his direction in the winter of 1880–'81 as far as Noe's Branch, and which was discontinued by reason of ice in the river, etc.

The Chief of Engineers having instructed Major King "to obtain the information and make the examination suggested as advisable," that officer, upon being relieved by me, transferred the examination and report upon this matter as unfinished business. The examination of this stream below Noe's Branch was therefore made under my direction by Assistant Engineer C. A. Locke, in October and November last, when the river was at a suitable stage, the distance being about 74 miles.

The Holston was examined from Kingsport, 1 mile above the forks, to Knoxville by Col. H. S. Long, as early as 1830, his report being reprinted and issued as House Ex. Doc. No. 167, Forty-third Congress, second session.

It was re-examined in part by Major W. R. King, as above stated, in 1881, as far as Noe's Branch, a short distance above Howell's Island.

This river drains an area of about 3,680 square miles, and is one of the four copious tributary streams—French Broad, Holston, Clinch, and Powell's—which, within a short distance, discharge their combined waters into the Tennessee.

Mr. Locke estimates the low-water discharge above mouth of French Broad River to be about 1,400 cubic feet per second, but after receiving the waters of the French Broad it is estimated to be so greatly increased as to secure from 3 to 5 inches greater depth in the natural low-water channel in the 4½ miles of its subsequent course to the Tennessee.

The obstructions met with in the lower section of the river are of the same general character as those found in the upper section, viz: reefs rocky shoals, isolated bowlders, and snags.

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These obstructions can be readily removed. The snags can be taken out; the rock ledges reduced; the isolated bowlders blasted; dams can be constructed where necessary to contract the water-way over the rock and gravel shallows; and thus the proposed improvement will be practically permanent, and the season of navigation lengthened by the securing of an open navigable channel of an average width of 100 feet and about 20 inches depth at natural low water from Knoxville to Noe's Branch.

The commerce of the Holston consists at present of log-rafts and flat-boats, laden with grain or other agricultural produce and lumber. This river, as is common with many other streams of like character, flows through a rich and fertile region, remote from transportation, thus forming the main highway; being easy of access as a means of transit.

A large amount of commerce thus seeks a market at the business centers on the main stream, the Tennessee, very many of the logs reaching as far as the large manufacturing establishments at Chattanooga, nearly 350 miles from the Forks of the Holston.

It is very difficult to get data in detail of this large and increasing commerce, for the river-men managing the rafts and boats, and who are usually the owners of the freight, take advantage of sudden rises, drop down-stream, sell at the best market en route, and return to their homes on its upper waters, without leaving any record available as statistical information.

Dams built by the State of Tennessee to aid the commerce of the Holston are yet standing at several points, attesting to the fact that the State deemed its improvement to be desirable.

Maps and report of Assistant Engineer C. A. Locke are forwarded herewith.

No appropriation has been made by the General Government for the improvement of the Holston River, but in the event of Congress making such an appropriation, it is desirable and would prove advantageous that it be made available for expenditure from the junction of the North and South Forks below Kingsport to Knoxville, a distance of about 154 miles, based upon the following estimates:

From the Forks to Noe's Branch, 80 miles (House Ex. Doc. No. 77, Forty-sixth Congress, third session)	$128,000
From Noe's Branch to Knoxville, 74 miles	219,000
Total estimate, improving Holston River, Tennessee, 154 miles	347,000

Very respectfully, your obedient servant,

J. W. BARLOW,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. C. A. LOCKE, ASSISTANT ENGINEER.

ENGINEER OFFICE, U. S. ARMY,
Nashville, Tenn., February 8, 1887.

COLONEL: In compliance with your instructions I have made a survey of Holston River from below Noe's Branch (Noeton post-office) to Knoxville, to ascertain the approximate cost of improving that section of river and in continuation of a survey made in 1880 by Mr. W. Y. Sanborn, under orders of Major W. R. King, Corps of Engineers, and reported on January 14, 1881.

About noon of October 24, 1886, the party left Noeton, and reached Knoxville early afternoon of November 5 following, a distance of about 74 miles, surveying a mean distance of about 6½ miles per day.

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The party consisted of myself, raft-pilot James F. Taylor, who sounded and gave general information, and a boatman in one canoe; a rodman and boatman in a second and co-operating canoe; a cook, camp outfit, and one boatman in a 6 by 22 feet flat-boat, propelled by oars when necessary.

Heavy fogs in the morning and a day's rain retarded operations, interfering especially by the moisture deposited on the lenses of instrument. To avoid undue delay some of the distances on pools requiring no improvement were estimated.

The stage of river (probably from 0.1 foot to 0.3 foot above low water) and the clearness of its waters were most favorable for the work.

Owing to the zigzag followed by survey, the distances from 0 were obtained by stepping off from the finished general map with dividers spaced to 2,000 feet.

More care was given the points requiring improvement, and the detail sketches are thought to embody the most reliable data, not only as a horizontal plan, but as to depths, these given in soundings. These soundings are the general depth at the point of sounding, and are not on top of isolated obstructions requiring removal.

The profile of water surface was obtained by running a level over places of marked fall or of currents of sufficient velocity to indicate a fall worthy of note. The fall over the pools was estimated as 0.04 foot per 1,000 feet to 0.0. The bottom shown on profile is only general; the soundings of note-books are correct, and give character of bottom.

November 1, above No. 35, a cross-section, etc., of river was made, to ascertain its volume. The mean maximum float velocities gave a volume of 1,701 cubic feet per second. The character of section, etc., caused me to estimate the actual volume at 1,530 cubic feet, and assuming the river as 0.1 foot above low water, I placed the low-water volume at about 1,400 cubic feet per second.

The flood-marks pointed out to me by citizens were not well defined, and are as follows:

Noeton, 1875, 32 feet above low water.

Gray's Mill, 1867, 35 feet above low water.

The general character of this river is so well known, that a lengthy description is thought unnecessary. Its banks are fixed, generally being rock or rocky hills on one side (the convex wearing) and alluvium bottom-lands on the other.

From Noeton to McKinley's Island No. 33 the pools alternate with gravel-bars of generally even descent; doubtlessly rock underlies and causes these shoals while the gravel filling in and overlying gives the uniformity of descent. In some places the rock ledges protrude boldly.

Below No. 33 the rock strata are more or less on edge called "Hog Backs" I believe, and are very often visible on the shoals and with more or less gravel. The pools of the lower portion of this last mentioned part, and especially those where marble is found, are deeper and longer than those above. On both sections the gravel is largely composed of fragments of 6 or 8 inches diameter, which stand out from the general mass. Along the middle and lower portions examined, these water-worn quartzites are of larger dimensions, often containing 2 cubic feet and forming a permanent feature of the bars and bottom. These are known locally as "River Rock" and are so designated in this report and its accompanying estimates and maps.

PROPOSED IMPROVEMENTS.

I. Where rock ledges appear, partial openings exist with much irregularity. Having selected the most favorable point, its prominences or sides should be blasted to the desired extent. If this blasting materially increases the water outlet through the reef, other natural and unused passages should be compensatingly obstructed, if desirable.

II. Isolated bowlders in deep water are blasted into fragments, which fall into or are rolled into the adjacent depths.

III. Where the "Hog Backs" occur, their surface is often very level, uniform, and shallow. To avoid blasting such places, dams have been resorted to whenever available.

IV. The "River Rock" and loose rock fragments should be removed from the existing and best channel, and wasted into proper dams. It is thought that the removal of the larger stones, which protrude above the general level of the bottom, will cause some of the fine gravel to scour out.

V. Contracting the channel by dams. These dams should be no higher than absolutely necessary, as any undue height increases the "head" of shoal and also may be an interference during the better stages of spring and winter.

The cross-dams connecting the training-dams to shore are intended to conserve the leakage water of the training-dams and to collect drift material outside of the channel. It was noticed that gravel, etc., collects rapidly around obstructions such as short spur-stock dams, etc.

The dams estimated for are shown in cross-section on the accompanying detail map. The long down-stream slope of the cross-dam is intended as an apron to prevent scour of the gravel. In either dam the intention is to use a few large stone on the outer

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sides to receive the current's force and also an encasement for the "River Rock." I notice that some old State dams with a few wooden poles of pen-like structure and filled in with "River Rock" have stood in currents of above an average velocity. I think the rock-casing preferable, and where the "River Rock" are small, stone should be mixed through the central filling; stone for these dams is abundant and generally convenient.

VI. The removal of snags. On this river steam will not be especially required for this purpose. The snags can be hoisted in whole or in part, cut into limbless lengths, and dumped overboard.

VII. Cutting overhanging trees. Generally these are less than 10 inches diameter at stump. They can be felled across a small barge, stripped of limbs, cut into lengths, and thrown overboard. I consider the hauling of these ashore as an unnecessary precaution.

PROBABLE COST.

In estimating cost I have supposed the work to occupy six consecutive years, and operations to be vigorously pushed during four months by three parties of between 50 or 60 laborers each.

Total cost, from accompanying tables	$161,698
Working-boats for each party, $3,000	9,000
Living boats for each party, $1,500	4,500
First year's outfit, tools, rope, explosives, etc., for each party, $3,000	9,000
Last five years' outfit, tools, rope, explosives, etc., for each party, $5,000	15,000
Engineering and contingencies, 10 per cent	19,802
Total	219,000

or $\frac{219000}{71}$,=nearly $3,000 per mile. While the above estimates are liberal, in consideration of the long shallow shoals with their strong currents, I do not look upon them as excessive, and believe it to be a close approximation of what the work will actually cost if completed. It is also probable that the above improvement will give a channel depth at low water of 20 inches, with a width varying from 90 feet at the head to about 140 feet at the lower end.

As to the availability of this river for commercial purposes after the above work is completed, I would say:

I. The proposed improvement will materially aid descending boats and rafts, and will materially lengthen the season of navigation. Those drawing 18 inches or less could probably run throughout the year.

II. For through steam-boat navigation I seriously doubt any material benefit from any system not using locks or other vertical lifts, for the following reasons:

1. Should the water be confined to one channel, straight or of easy curvature, the descent would be so precipitous that the ordinary steamboat would hardly ascend it in several localities.

2. Owing to the considerable fall to be overcome at these shoals and to the depths of the pools below them, it would hardly be advisable to attempt a decrease of these slopes by the partial obstructions of the pools.

3. Warping over such long distances is tedious, expensive, and dangerous, and I doubt much if steamboat men would avail themselves of such a doubtful privilege.

4. When the river would reach a sufficient flood stage for boats to ascend, they would do so as easily without the aid of the proposed improvements as with it. (Citizens told me that the few boats which had ascended on unusually high stages were compelled to warp through Lost Creek Shoals No. 25.)

For the above reasons I made no estimates for warping facilities.

As regards the needs of that section and the wish of the citizens, I would say: That the river traverses a most fertile region, well timbered, and abounding in marbles deservedly noted for variety, delicacy of coloring, and which work most easily. A glance at a map will show that the right or westerly side is cut off from communication, and while the citizens on both shores wish the stream improved, those on the right are especially anxious for it.

The present commerce of this river is confined to the drifting down-stream of barges loaded with grain and country produce and rafts of logs or lumber. From above McBee's Island No. 30, about 35 miles above Knoxville, these boats do not return; they are generally about 16 feet by 80 feet. Those going from below McBee's Island to either Knoxville or East Tennessee, Virginia and Georgia Railroad Bridge at Strawberry Plains, are about 8 feet by 60 feet and are brought back by poles. During the last fiscal year, about 300 boats came out of Holston River to Knoxville. At present I cannot report satisfactorily as to the rafts, but hope yet to receive further replies to inquiries. No account is kept of the rafts.

Very respectfully, your obedient servant,

C. A. LOCKE,
Assistant Engineer.

Lieut. Col. J. W. BARLOW,
Corps of Engineers.

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Estimate, probable cost of improving Holston River, Noe's Branch to Knoxville, distance 74 miles.

No. of improvement.	Name.	Distance in feet from 0.	Length in feet.	Fall in feet.	Excavation.				Dams.			Snags and overhanging trees.		Grand total cost of improvement.	Remarks.
					Loose rock.	Total cost of removal.	Solid rock.	Total cost of removal.	Linear feet.	Cubic yards.	Total cost.	Number.	Cost.		
					Cub. yds.		*Cub. yds.*								
	Foot of pool below Noe's Branch.	0	0	0											
1	Foot of 1	60	60	0.93	13	$26						4	$2	$28	River rock and gravel shoals.
2	Foot of 2	2,500		0.10			24	$24						24	Rock reef, 8 feet wide, 8 feet deep above it, and 10 feet below, flat boulders below.
	Pool to head of 3	7,600		0.20											
3	To foot	8,000	400	0.55	20	40						10	4	44	Even decent, trees 2,000 feet below on left.
	Pool to head of 4	17,000		0.36											
4	Foot Howell's Island	18,050	1,050	3.76	30	60	36	108	1,300	1,180	$3,540			3,708	
	Pool to head of 5	28,500		0.40											
5	Foot Turley's Mill	30,000	1,500	4.54	100	200			2,800	2,300	6,900	15	6	7,106	
	Pool to head of 6	32,000	2,000	0.08											
6	Foot of 6	33,600	1,600	1.17	200	400								400	Gravel rapids.
	Pool to head of 7	37,000	3,400	0.13											
7	Foot of 7	37,020	20	0.35	35	60								60	Reefs of river rock.
	Pool to head of 8	38,000	980	0.03											
8	Foot of 8	39,170	1,170	1.10	140	280	7	7						287	Four reefs of river rock.
	Pool to head of 9	44,000	4,830	0.20											
9	Foot of 9	45,500	1,500	2.30	200	400						1	1	401	Gravel reefs.
	Pool to head of 10	49,500	40,000	0.16											
10	Foot of 10	49,670	170	1.10	6	12	21	63						75	
	Head of 11	49,670													
11	Foot of 11	50,400	730	0.75	21	32	10	30						62	
	At Cave Springs											1	5	5	
	900 feet above No. 12											1	5	5	
	Pool from 11 to 12	63,600	13,200	0.60											
12	Foot of Collasou's Island	65,000	1,400	4.56	1,400	1,400								1,400	Build this into dams 120 feet from right shore.
	Pool to head of 13	70,500	5,500	0.22											
13	To foot Tates Tow-pool	71,400	900	1.80	305	610								610	

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	Pool to head of 14	82,000	10,600	0.40	6	12						1	4	16	Snag 1,700 feet below Tate's Tow Head. Rock 600 feet above Hull's Mill.
14	Foot of Tow-head	83,300	1,300	1.75	150	300	30	30						330	
	Pool to head of 15	87,500	4,200	0 16											
15	Mossy Creek	89,200	1,700	3.40			70	170	1,400	1,880	4,440	3	12	4,622	
	Pool to head of 16	93,200	4,000	0.16											
16	Clevingers Shoals	94,200	1,000	2.41			60	120	1,000	2,890	5,370	8	4	5,554	Jake "river rock" from channel for dams.
	Pool to head of 17	95,000	800	0.04											
17	Foot of 17	95,000	50	0.54	25	50	30	90						140	
	Pool to head of 18	95,500	500												
18	Foot of 18	95,500	30	0.40			25	25						25	
	Pool to head of 19	100,000	4,500	0.18											
19	Foot of 19	104,100	4,100	3.70	52	104	20	60				5	6	170	
	Pool to head of 20	106,000	1,900	0.08											
20	Foot of 20	108,100	2,100	0.86	12	24	4	4				1	4	32	
	Pool to head of 21	114,100	6,000	0.24											
21	Gilmores Island	116,000	1,900	2.56			9	9	800	2,350	4,350	2	8	4,367	See remarks in report, snags above island.
	Pool to head of 22	119,000	3,000	0.12											
22	Foot of 20	119,900	900	2.00	20	40	80	240						280	
	Pool to head of 23	128,000	8,100	0.32											
23	Smoky Island	135,200	7,200	14.10	80	160			4,400	11,120	25,020			25,180	
	Pool to head of 24	137,000	1,800	0.08											
24	Foot of 24	148,000	11,000	1.30			1	1				3	12	13	
	Pool to head of 25	154,000	6,000	0.24											
25	Lost Creek	161,400	7,400	10.45	400	970	802	2,495	1,750	6,250	16,800	1	4	20,269	
	Pool to head of 26	162,000	600												
26	Foot of 26	164,000	2,000	2.70			91	261						261	
	Pool to head of 27	169,000	5,000	0.20											
27	Foot of 27	174,000	5,000	0.40			9	9				2	8	17	No sketch.
	Pool to head of 28	195,000	1,000	0.04											
28	Foot of 28	175,400	400	0.28			25	25				2	8	33	
	Pool to head of 29	184,400	9,000	0.36											
29	Nances Shoals	186,600	2,200	3.84			29	69	1,400	3,100	5,400			5,469	Loose stone and "river rock" should be taken from channel for these dams.
	Pool to head of 30	193,000	6,400	0.25											
30	McBee's Island	197,200	4,200	6.61					1,800	2,900	4,800	400	80	4,880	Channel close in on large island.
	Pool to head of 31	215,000	17,800	0.40											
31	Snaggy Island	218,000	3,000	2.37	30	60	3	9	600	300	900	302	68	1,037	
	Pool to head of 32	225,000	7,000	0.28											
32	McKinney's Upper Island	227,000	2,000	1.60					250	1,880	2,340	300	60	2,400	
	Pool to head of 33	230,000	3,000	0.10											
33	McKinney's Lower Island	236,000	6,000	6.03	40	80	*42	164	950	2,650	4,200	500	100	4,544	
	Pool to head of 34	238,000	2,000	0.07											
34	Foot of 34	246,000	8,000	1.70			*50	120				232	128	308	No sketch.
	Pool to head of 35	249,000	3,000	0.10											

*Strata on edge, "hog back."

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Estimated probable cost of improving Holston River, Noe's Branch to Knoxville, distance 74 miles—Continued.

No. of improvement.	Name.	Distance in feet from 0.	Length in feet.	Fall in feet.	Excavation.				Dams.			Snags and overhanging trees.		Grand total cost of improvement.	Remarks.
					Loose rock.	Total cost of removal.	Solid rock.	Total cost of removal.	Linear feet.	Cubic yards.	Total cost.	Number.	Cost.		
					Cub. yds.		*Cub. yds.*								
35	Thornton's Island	256,400	7,400	3.20	106	$212	*53	$212	800	3,300	$5,700	....	.....	$6,124	
	Pool to head of 36	261,000	4,600	0.14											
36	Cobb's Shoals	264,400	3,400	4.44	170	340	*272	1,088	2,200	6,200	15,600	4	$16	17,044	Snags 5,000 feet above trap.
	Pool to head of 37	269,000	.....	0.12											
37	1,500 feet to 200 feet above 38	269,000	.....	0.60	140	280	.....	.....	.....	.....	.....	.....	.....	280	Two bars very large "river rock."
	Pool to head of 38	271,000	2,000	0.00											
38	East Tennessee, Virginia and Georgia Railroad Bridge.	271,000	.....	0.10	110	220	.....	.....	.....	.....	.....	.....	.....	220	Bridge 520 feet in clear above low-water channel on left shore and span.
	Pool to head of 39	276,000	5,000	0.10											
39	McBee's Fish-trap	227,500	1,500	1.35	90	180	*3	12	810	2,340	4,920	60	14	5,126	
	Pool to head of 40	286,000	8,500	0.15											
40	Howard's Barb and Flat Creek Tow-head.	293,200	7,200	9.07	148	292	*8	16	2,000	4,950	9,000	25	8	9,316	
	Pool to head of 41	296,000	2,800	0.03											
41	Foot of 41	300,000	4,000	0.72	130	260	*32	64	.....	.....	.....	1	4	328	No sketch.
	Pool to head of 42	304,000	4,000	0.04											
42	.....	304,600	600	1.74	100	200	.....	.....	.....	.....	.....	.....	.....	200	Make into dams as marked on sketch.
	Pool to head of 43	308,000	3,400	0.08											
43	Doak's Bar	309,000	1,000	1.80	200	400	*160	320	.....	.....	.....	.....	.....	720	At old marble quarry where débris comes 60+ feet out principal fall at reef just above quarry. No sketch.
	Pool to head of 44	310,000	1,000	0.01											
44	Double Fish-trap	310,200	200	1.98	94	188	*6	12	.....	.....	.....	2	8	208	
	Pool to head of 45	330,000	19,800	0.20											
45	Cabbage Island	331,200	1,200	0.40	.....	.....	.....	.....	.....	570	810	100	30	840	
	Pool to head of 46	337,400	6,200	0.06											
46	Armstrong Island	340,600	3,200	6.50	432	864	*37	848	1,200	4,000	7,200	.....	.....	8,412	
47	Brooks Eddy	351,600	14,000	0.10	.....	.....	.....	.....	.....	.....	.....	4	16	16	No sketch.

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48	Boyds Island	858,700	4,100	0.54	150	500		*317	1,258	1,000	5,500	6,750	20	8	4,346			
	Pool to head of 49	274,000	15,300	0.50														
49	Foot of 49	274,400	1,400	1.03				*26	53	1,300	2,900	6,480	10	40	6,573	No sketch.		
	Pool to 50	380,000	4,600	0.03														
50	Gravel Reef	380,100	100	1.00	150	500				600	1,740	3,420	1	4	3,784			
	Pool to Knoxville Bridge	898,000	7,900	0.06														

* Strata of edge, "hog back."

Elevation of low-water surface above sea level at Knoxville	feet	811.00
Total distance	miles	74.00
Total fall	feet	141.87
Cost of work		$161,698
Tools, etc		37,500
Engineering and contingencies		19,802
Total cost of improvement		219,000

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APPENDIX C C.

IMPROVEMENT OF THE OHIO, MONONGAHELA, ALLEGHENY, BIG SANDY, LITTLE KANAWHA, GUYANDOTTE, AND BUCKHANNON RIVERS; OPERATING AND CARE OF DAVIS ISLAND LOCK AND DAM, OHIO RIVER; LOCK AND DAM NO. 9, MONONGAHELA RIVER, AND THE LOCKS AND DAMS ON THE MUSKINGUM RIVER; CONSTRUCTION OF ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO; OF HARBORS OF REFUGE NEAR CINCINNATI AND AT THE MOUTH OF THE GREAT KANAWHA RIVER AND OF LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

REPORT OF LIEUTENANT-COLONEL WILLIAM E. MERRILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating and care of Davis Island Dam, Ohio River.
3. Monongahela River, West Virginia and Pennsylvania.
4. Operating and care of lock and dam No. 9, Monongahela River.
5. Allegheny River, Pennsylvania.
6. Dam at Herr's Island, Allegheny River.
7. Ice-harbor at mouth of Muskingum River, Ohio.
8. Operating and care of the locks and dams on the Muskingum River, Ohio.
9. Harbor of refuge near Cincinnati, Ohio.
10. Harbor of refuge at mouth of Great Kanawha River, West Virginia.
11. Big Sandy River, West Virginia and Kentucky.
12. Guyandotte River, West Virginia.
13. Little Kanawha River, West Virginia.
14. Buckhannon River, West Virginia.

EXAMINATIONS.

15. For ice-harbor at Paducah, Kentucky.
16. Bar at the mouth of Limestone Creek, in the harbor of Maysville, Kentucky.
17. Big Hockhocking River, Ohio, from its mouth to Coolville.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, August 30, 1887.

SIR: I have the honor to submit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1887.

First Lieut. Lansing H. Beach, Corps of Engineers, has been on duty under direction of this office throughout the fiscal year, and First Lieut. Cassius E. Gillette, Corps of Engineers, since April 30, 1887.

Until May 6, 1887, the Big Sandy, Little Kanawha, Guyandotte, and Buckhannon rivers were under charge of Maj. James C. Post, Corps of Engineers.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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C C 1.

IMPROVEMENT OF THE OHIO RIVER.

The river and harbor act of August 5, 1886, contained the following item in reference to the Ohio River:

Improving the Ohio River: Continuing improvement, three hundred and seventy-five thousand dollars; out of which sum thirty-seven thousand five hundred dollars are to be expended at Grand Chain in removing rocks and other obstructions to navigation at that locality; also eighteen thousand seven hundred and fifty dollars may be expended in constructing or aiding in the construction of such an embankment on the south side of the Great Miami River, near its junction with the Ohio, as may be necessary to confine the waters of the Great Miami in great floods to the general course of its channel at or near the Ohio, to the end that the formation of the bar in the Ohio River now forming and obstructing navigation may be arrested; also thirty-seven thousand five hundred dollars, or so much thereof as may be necessary, of said appropriation shall be expended in constructing five ice-piers, pursuant to the present or prospective plans of the Chief of Engineers, at or near the following places, to wit: One at Pomeroy, Ohio; one at Middleport, Ohio; one at Gallipolis, Ohio; and one at Ironton, Ohio; and one at or near Ashland, Kentucky, on the south side of the Ohio River: *Provided*, That the Secretary of War is hereby authorized and directed to obtain, if he can do so without cost to the United States, perpetual leases or conveyances of the riparian rights of the property-owners at each of said localities, in the event said ice-piers, or any one of them, shall be located where there is no improved landing-place: *And provided further*, That at localities where there are improved landings he shall first obtain a relinquishment of wharfage rights and dues in favor of water-craft seeking protection from damage by ice; and no part of this appropriation shall be used for such purpose until the foregoing conditions are complied with. Also, out of said appropriation for the Ohio River eighteen thousand seven hundred and fifty dollars for removing obstructions at the mouth of Licking River; also eleven thousand two hundred and fifty dollars for completing ice-harbor at Four-Mile Bar, near Cincinnati; also twenty thousand dollars, or so much thereof as may be necessary, for Davis Island Dam.

During the fiscal year the following work was done on the river:

DAMS AND DIKES.

Davis Island Dam, 5 miles below Pittsburgh.—As the expenses of this work are now met from the indefinite appropriation for "operating and care of canals and other works of navigation," the annual report on this dam will be found elsewhere. For reasons that are stated in full in the special report, it is considered essential to make a drift-gap in this dam for the ready passage of the great quantity of floating material that comes down from above and seriously embarrasses the working of the apparatus. The estimated cost of this drift-gap, with the bear-trap gates and masonry walls, is $20,000.

Merriman Bar, 9 miles below Pittsburgh.—Construction of a guiding-dike under contracts with J. B. Holbrook, dated October 23, 1884, and Stubbs & Lackey, dated October 31, 1885.

During the year this dike was extended 1,350 feet and finally completed; its full length is 2,200 feet.

There has been expended on this work:

Oak timber	feet, B. M..	395,307
Riprap stone	cubic yards..	10,298
Drift-bolts	pounds..	20,335
Spikes	do....	497
Excavation made	cubic yards..	2,006

Black's Island, 54 miles below Pittsburgh.—Rebuilding old dam to close right-hand chute, under contract with Porter, Tucker & Mahan, dated November 4, 1884.

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The gap of 539 feet remaining unfinished at the end of the last fiscal year has been closed, and the dam has been completed for its full length of 2,634 feet.

The following materials were used in its construction:

Oak timber	feet, B. M..	326,568
Hemlock timber	do....	129,670
Riprap stone	cubic yards..	15,104
Drift-bolts	pounds..	31,551
Spikes	do....	1,727
Excavation made	cubic yards..	337

Brown's Island, 63 miles below Pittsburgh.—Repairs of dam under contract with Porter, Tucker & Mahan, dated November 4, 1884.

The repairs of this dam, which consisted chiefly in adding a timber apron and a protection of riprap to prevent scour on the lower side of the work, have been completed.

The following materials have been expended on this work:

Oak timber	feet, B. M..	38,771
Riprap stone	cubic yards..	2,162
Drift-bolts and spikes	pounds..	2,662
Brush	cords..	33.7
Gravel	cubic yards..	1,161

Wheeling Island, 91 miles below Pittsburgh.—Construction of dam 500 feet long to close chute behind Wheeling Island; under contract with I. V. Hoag, jr., dated December 1, 1884.

This work has been completed, the total amount of material expended being as follows:

Oak timber	feet, B. M..	534,229
Riprap stone	cubic yards..	18,055
Drift-bolts	pounds..	49,483
Spikes	do....	11,008
Excavation made	cubic yards..	6,252

Captina Island, 107 miles below Pittsburgh.—Rebuilding old dam to close left-hand chute; under contracts with John B. Holbrook, dated October 22, 1884, and Stubbs & Lackey, dated October 31, 1885.

This dam has been completed for its full length of 2,000 feet.

The following materials have been expended:

Oak timber	feet, B. M..	263,444
Hemlock timber	do....	100,488
Riprap stone	cubic yards..	18,388
Drift-bolts	pounds..	17,055
Spikes	do....	1,850
Brush	cords..	69.7
Excavation made	cubic yards..	730

Fish Creek Island, 112 miles below Pittsburgh.—Rebuilding old dam to close left-hand chute; under contracts with John B. Holbrook, dated October 22, 1884, and Stubbs & Lackey, dated October 31, 1885.

This dam has been completed, with a total length of 1,800 feet.

The following materials have been expended in its construction:

Oak timber	feet, B. M..	220,362
Hemlock timber	do....	68,400
Riprap stone	cubic yards..	13,077
Drift-bolts	pounds..	16,196
Spikes	do....	521
Brush	cords..	91
Excavation made	cubic yards..	1,236

Three Brothers Islands, 157 miles below Pittsburgh.—Construction of dam from the West Virginia shore to the head of the Middle Brother to close the chutes between the left bank and the Upper Brother, and

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between the Upper and Middle Brother; under contract with J. F. King, dated October 23, 1884.

The timber work of this dam was reported as complete on June 30, 1886. During the year since that date the necessary ballast has been added, and the work is now complete, with a total length of 2,900 feet.

MATERIALS EXPENDED.

Oak timber	feet, B. M..	356,724
Oak timber in place of hemlock	do....	117,136
Riprap stone	cubic yards..	32,368
Drift-bolts	pounds..	33,683
Spikes	do....	4,100
Excavation made	cubic yards..	625

Sand Creek Bar, 220 miles below Pittsburgh.—Construction of a guiding dike to deepen the channel over a shoal about a mile below the mouth of Sand Creek, under a contract with J. C. Graham, dated October 27, 1884.

This work has been finished by adding the necessary ballast, and completing the paving of the top surface. Its total length is 1,485 feet, and the following materials were expended in its construction:

Oak timber	feet, B. M..	381,540
Riprap stone	cubic yards..	14,427
Drift-bolts and spikes	pounds..	23,727
Excavation made	cubic yards..	306

Eight Mile Bar, 453 miles below Pittsburgh.—Construction of a guiding-dike from the Kentucky shore, in order to deepen the water on this bar; under contract with J. J. Shipman, dated November 28, 1884.

This dike has also been completed, its total length being 2,400 feet.

The following materials have been expended:

Oak timber	feet, B. M..	698,420
Riprap stone	cubic yards..	23,224
Drift-bolts and spikes	pounds..	52,357
Excavation made	cubic yards..	198

The effect of this dike has been to deepen the shoal water at its site, but boats are still troubled by shoal water above the dike. As the river in this vicinity has an abnormal low-water width, it is evident that one or more dikes will be needed at points higher up, before this section of river will be in a satisfactory condition.

Rising Sun Bar, 502 miles below Pittsburgh.—Construction of a dike, just above the town of Rising Sun, in order to force the low-water channel away from the right bank, and thus create a new low-water channel, coinciding with high-water channel; under contract with Kirk & Co., dated October 22, 1884.

This dike was completed during the year 1886, and has fully accomplished the purpose for which it was built. Its length is 2,700 feet, and the following materials were used in its construction:

Piles	number..	1,370
Brush	cords..	7,996
Riprap stone	cubic yards..	21,107
Oak timber	feet, B. M..	342,993
Drift-bolts	pounds..	25,866
Spikes	do....	1,050
Bolts, nuts, and washers	do....	2,464
Excavation made	cubic yards..	225

Hitherto the upper crossing at Rising Sun has been the first place to get shallow after the spring floods, and boats have usually stuck on this

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bar when they could cross with ease all other bars below Cincinnati. After a month or two of low water, the channel at this point always deepened, and ultimately became better than at many other places. Since the completion of the dike the conditions have entirely changed, and Rising Sun Bar has ceased to control the higher stages of low-water navigation.

Middle of Grand Chain, 946 miles below Pittsburgh.—Construction of a third dike from the Illinois shore, intermediate between the other two, in order to force the channel from the main body of rocks which lie along this shore; under contract with I. V. Hoag, jr., dated December 1, 1884.

The substructure of this dike has been built to a length of 1,598 feet, and the superstructure has been added for a length of 1,228 feet. The dike when completed will be 3,000 feet long.

The following materials have been expended to date:

Oak timber	feet, B. M..	420,865
Riprap stone	cubic yards..	16,489
Drift-bolts	pounds..	29,677
Brush	cords..	1,083
Excavation made	cubic yards..	34

REMOVING ROCKS AT GRAND CHAIN.

Under the allotment of $37,500 from the appropriation for improving the Ohio River, made by the act of August 5, 1886, a contract was entered into on December 6, 1886, with the Crescent City Wrecking Company of New Orleans, La., for the removal of rock obstructions at the Grand Chain.

Owing principally to the high stage of the river, work under this contract was not begun until May, 1887. The method adopted by the contractors is to break up the projecting points of the ledge by surface blasting, and to remove the débris by dredging.

At the close of the year 897.2 tons of rock had been removed from the channel opposite the upper dike.

ICE-PIERS.

Under the allotment made in the river and harbor act of August, 1886, surveys were made at each of the localities named in the act and sites were selected for the construction of ice-piers. Relinquishment of wharfage rights and dues in favor of water-craft seeking protection from ice were obtained at Pomeroy, Middleport, Gallipolis, and Ironton; but as the papers submitted were not considered sufficiently formal by the Department of Justice they were returned with request that formal deeds of relinquishment be prepared and again submitted for approval. The preparation of such deeds is now in progress.

At Ashland it was found impossible to obtain the necessary relinquishments in favor of water-craft seeking protection from ice, and the project of ice-piers at this locality was therefore abandoned.

REMOVING OBSTRUCTIONS AT MOUTH OF LICKING RIVER.

In my last annual report it was recommended that the allotment of $18,750, made for this work by act of August 5, 1886, be withheld awaiting further appropriations, in order that a greater amount of work might be included in one contract, and thus the aggregate cost of the improvement might be reduced; but as no further appropriation was

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made in 1887, it has been deemed advisable to expend the available funds by beginning at the upper end of the shoal in the Licking River and removing a portion of the rock bar, completing the proposed channel as far as practicable toward the Ohio River.

Proposals for this work were solicited by advertisement dated May 26, to be opened on July 5, 1887.

GREAT MIAMI EMBANKMENT, 489 MILES BELOW PITTSBURGH.

The object of this embankment, as stated in the river and harbor act of August 5, 1886, is to confine the waters of the Great Miami in great floods, "to the end that the formation of the bar in the Ohio River now forming and obstructing navigation may be arrested."

I am unable to identify the bar referred to in the above quotation, nor do I see how the anticipated effect could be produced on any bar in this vicinity. The only apparent use of this embankment is to protect the town of Lawrenceburgh from inundation.

As the track of the Lawrenceburgh branch of the Cincinnati, Indianapolis, Saint Louis and Chicago Railroad already acts as a levee against moderate floods, it is proposed, in co-operation with the city, to raise this track to a height of 3 feet below the high water of 1884; the available funds will not permit the construction of a higher embankment.

Negotiations to this end are still pending, but it is believed that work will be begun before the end of the calendar year.

CONSTRUCTION OF LEVEE AT JEFFERSONVILLE, INDIANA.

The additional work required for the proper drainage of the area inclosed by this levee was finished and the work completed in August, 1886. This levee, which is built along the river front of the town of Jeffersonville, has a total length of 5,818 feet, and is 2 feet above the flood of 1884, the highest ever known at this locality.

DREDGING.

Owing to the late date of the passage of the river and harbor act of 1886, and to the extensive repairs required upon the dredges and dump-scows, which had lain idle since the close of operations in 1884, it was impracticable to begin the work of dredging until the 11th of October, and work had to be suspended on November 15 on account of high water, thus leaving but a little over one month for actual work. At the close of operations the dredges were taken to winter quarters in the mouth of the Muskingum River.

The following is a statement of the season's work:

Mustapha Island, 194½ miles below Pittsburgh.—The improvement at this point consisted in widening and straightening the channel by dredging the point of the island bar at the head of the chute on the Ohio side. This work was not completed, owing to high water.

Excavation made October 11 to October 28 and November 10 to November 15, 23,026.6 cubic yards.

Seven large rocks, weighing a total of 20.7 tons, and two snags were also removed by the dredges at this point.

Newberry Bar, 193½ miles below Pittsburgh.—The work of removing a lump in the channel at this place was begun on October 28, the water being too low for work at Mustapha, and was continued until Novem-

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ber 10, when work was again resumed at the latter point. This work is incomplete and will require additional dredging in 1887.

Excavation made October 28 to November 10, 23,827.5 cubic yards. Five rocks were also removed, aggregating a weight of 13 tons.

The following tables show the amount and cost of dredging operations for the season of 1886:

DREDGES IN COMMISSION, 1886.

Time at work:		Days.
Dredging gravel		33
Removing rocks and logs		2
Total		35
Time lost:		
Traveling		7
Accidents		2
High water		7
Sundays		9
Total		25
Total in commission		60
Gravel excavated per day of work	cubic yards	1,419.9
Gravel excavated during the season	do	46,855.0
Large rocks removed (number, 12)	tons	33.7
Logs removed (number, 2)	do	2.5
Equipment:		
Per day in commission		$8.21
Per day of work		14.06
For the season		492.33
Towing:		
Per day in commission		46.77
Per day of work		80.01
For the season		2,806.02
Repairs:		
Per day in commission		1.17
Per day of work		2.01
For the season		70.50
Salaries:		
Per day in commission		41.87
Per day of work		71.77
For the season		2,512.25
Total:		
Per day in commission		98.02
Per day of work		168.00
For the season		5,881.10

DREDGES OUT OF COMMISSION, 1886.

	Days.	
In ordinary	255	
Annual repairs	40	
Total	305	
Cost:		
Salaries in ordinary	$1,236.75	
Towing, fuel, etc	822.70	
Total in ordinary		$2,059.45
Salaries during annual repairs	2,025.08	
Annual repairs	4,754.04	
		6,779.12
Total out of commission		8,838.57
Per day out of commission		28.98
Per day in ordinary		7.77

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COST OF WORK, INCLUDING ALL EXPENDITURES DURING 1886.

Dredging	$13,878.55
Removing rocks and logs	841.12
Total	14,719.67
Cost per unit:	
Per cubic yard gravel excavated	294.
Per day in commission	245.33
Per day of work	420.56

October and November, 1886.

Miles below Pittsburgh.	Place.	Kind of work.	Days of work.	Excavation.			Rocks and logs.		Expenditures.		
				Cubic yards gravel.	Cubic yards per day of work.	Cost per cubic yard.	Number.	Tons weight.	Gravel.	Rocks and logs.	Total for 1886.
						Cts.					
194½	Head of Mustapha Island.	Dredging gravel	22	23,027	1,046.7	40.2	....	.....	$9,252.37	.....	$9,252.37
194½	....do.....	Removing rocks and logs.	1	.....	.....	....	9	23.2	.....	$420.56	420.56
193½	Foot of Newberry Bar.	Dredging gravel	11	23,828	2,166.2	19.4	....	.....	4,626.18	.....	4,626.18
193½	....do.....	Removing rocks	1	.....	.....	....	5	13.0	.....	420.56	420.56
	Total.....	.....	35	46,555	1,419.9	29.4	14	36.2	13,878.55	841.12	14,719.67

SNAGGING.

After the funds appropriated by the act of August 5 became available for expenditure, the snag-boat *E. A. Woodruff* was put in order for the season's work, which was begun on September 23. The boat worked over the river from Cincinnati to Louisville, thence to Pittsburgh, thence to the head of Grassy Flats, 118 miles below Cincinnati, and thence to the mouth of the Kentucky River, where she went into winter quarters on December 6. The total distance traveled during the season, including the minor trips made while on the above-mentioned routes, was 1,575 miles.

Two hundred and thirty-one snags, 27 large rocks, and 19 wrecks removed during the season.

Among the wrecks the most notable were those of the steamers *Potomac*, *Emma Graham*, and *Condor*, at and near Pomeroy, Ohio, and that of the steamer *Diurnal* at Grassy Flats, 19 miles above Louisville.

Among the larger snags removed may be mentioned one at Twelve-Mile Island, 80 feet long and 6 feet in diameter, weighing 101 tons; one at Aurora, Ind., 75 feet by 8 feet, weighing 90 tons; and one at Mason City, Ind., 90 feet by 6 feet, weighing 80 tons.

For the effect of Government work on the Ohio River in reducing rates of freight and insurance, I refer to the annexed letter from S. F. Covington, Esq., one of the leading underwriters of Cincinnati, and an authority on such subjects.

As questions have been asked this office as to the effect of low water and of ice on the commerce of the Ohio River below Louisville, the annexed letters from Col. W. W. Hite, president of the Louisville and Evansville Packet Company, and from Capt. F. Hopkins, president of the Evansville, Paducah and Cairo Packet Company, are submitted in reply to such questions.

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ESTIMATE.

As no action was taken on my last year's estimate, it is again submitted. The estimate for the Falls of the Ohio has been furnished by Maj. Amos Stickney, Corps of Engineers, who has charge of this work, although the funds expended on it are drawn from the general appropriation for the improvement of the Ohio River. For information on this subject reference is made to Maj. Stickney's report.

The estimate for the improvement of the Ohio is therefore as follows:

Dams and dikes	$888,000
Drift gap in Davis Island Dam	20,000
Obstructions in mouth of Licking River	56,250
Falls of the Ohio River	30,000
Snagging	25,000
Dredging	16,500
Removing rocks	5,000
Office expenses, inspection, engineering, and contingencies	35,500
Total	1,076,250

Money statement.

July 1, 1886, amount available	$53,822.05	
Amount appropriated by act approved August 5, 1886	375,000.00	
		$428,822.05
November 16, 1886, allotted for improving Falls of the Ohio, to be accounted for by Maj. A. Stickney, Corps of Engineers	20,000.00	
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	184,122.77	
July 1, 1887, outstanding liabilities	25,784.91	
		229,907.68
July 1, 1887, amount available		198,914.37
Amount that can be profitably expended in fiscal year ending June 30, 1889		1,076,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for constructing a decked flat-boat for service with the Ohio River dredges, opened September 17, 1886.

No.	Bidders.	Amount.
1	John F. King & Bro	$1,223
2	Elias Ehler	1,375

The contract was awarded to John F. King & Bro., and was executed September 29, 1886.

Abstract of proposals for towing in connection with the United States dredges Ohio and Oswego, opened September 20, 1886.

No.	Bidders.	Tow-boat offered.	Price per day.
1	Fulton Tow-boat Company	Little Andy Fulton	$34.50
2	D. A. Davis	Pat. McLaughlin	35.00
3	J. M. Bowell	J. M. Bowell	40.00
4	P. J. Capehart	Katie Timmonds	45.00
5	G. W. Thompson	Iron Cliff	49.00

The contract was awarded to the Fulton Towboat Company, and was executed September 29, 1886.

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Abstract of proposals for crib extension at Davis Island Dam, opened October 16, 1886.

No.	Bidders.	Soft timber, per thousand.	Oak, per thousand.	Stone, per ton.	Masonry per cubic yard.	Excavation, per cubic yard.	Drift bolts, per pound.	Screw bolts, per pound.	Aggregate.
							Cts.	Cts.	
1	James S. Routh	$20	$30	$. 75	$4.00	$0.50	4	4½	$2,485.36
2	J. J. Shipman & Co	19	19	1.24	4.50	.40	4	6½	2,025.96
3	Water and Gas Works Construction Company	18	25	1.45	3.75	.49	4½	10	3,345.86
4	John F. King	20	24	1.33	5.00	.50	4½	10	3,350.66
5	I. V. Hoag, jr	20	30	1.65	5.00	.49	5	5	3,031.20
6	Harrold McDonald	22	33	2.45	4.50	2.00	6	6	5,514.84
7	Booth & Flinn	25	40	3.00	7.00	1.00	4	4	5,806.16

The contract was awarded to James S. Routh, and was executed October 26, 1886.

Abstract of proposals for filling and paving behind lock wall at Davis Island Dam, opened October 19, 1886.

No.	Bidders.	Earth filling, 8,000 cubic yards, per cubic yard.	Cinder filling, 8,000 cubic yards, per cubic yard.	Paving 252 squares, per square.	Aggregate with earth filling.	Aggregate with cinder filling.
1	F. Gwinner	$0.50	.....	$16.00	$8,032	.....
2	Harrold & McDonald	.79	.....	11.50	9,218	.....
3	James S. Routh	.30	$0.40	25.00	10,300	$9,500
4	Water and Gas Works Constructing Company	.60	.60	19.00	9,588	9,588
5	Martin Dougherty	.75	.75	15.00	9,780	9,780
6	John J. Shipman & Co	.59	.59	22.00	10,264	10,264
7	Watson & Sproat	.63	.....	26.25	11,655	.....
8	I. V. Hoag, jr	.75	.....	26.00	12,552	.....
9	John F. King	1.50	1.50	18.50	16,662	16,662
10	Booth & Flinn	1.25	.....	29.00	17,308	.....

The contract was awarded to F. Gwinner, and was executed October 27, 1886.

Abstract of proposals for removing rocks from channel at Grand Chain, opened October 26, 1886.

No.	Bidders.	Per ton.
1	C. Arthur Cole	$4.40
2	Crescent City Wrecking Company	4.85
3	I. V. Hoag, jr	12.90
4	Edward R. Lowe	13.25

The contract was awarded to the Crescent City Wrecking Company, and was executed December 6, 1886.

Abstract of proposals for lock-gate engines for use at Davis Island Dam, opened February 28, 1887.

No.	Bidders.	Amount.
1	John G. Fritsch	$2,546
2	Thomas Carlin's Sons	2,873

The contract was awarded to John G. Fritsch, and was executed March 4, 1887.

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Abstract of proposals for towing in connection with United States dredges Ohio and Oswego, opened May 14, 1887.

No.	Bidders.	Rate per day.
1	Stephen D. Davis	$40
2	John Barrett & Son	45

The contract was awarded to Stephen D. Davis, and was executed May 31, 1887.

Abstract of contracts for improving Ohio River, in force during the fiscal year ending June 30, 1887.

Contractors.	Improvement.	Date.	To expire.	Remarks.
Stubbs & Lackey	Dike at Merriman Bar.	Oct. 31, 1885	Aug. 31, 1886	Extended to June 30, 1887, and completed.
Porter, Tucker & Mahan.	Dam at Black's Island.	Nov. 4, 1884	Dec. 31, 1885	Do.
Do	Repair of dam at Brown's Island.	Nov. 4, 1884	Dec. 31, 1885	Do.
I. V. Hoag, jr	Dam at Wheeling Island.	Dec. 1, 1884	Dec. 31, 1885	Extended to Aug. 31, 1886, and completed.
Stubbs & Lackey	Dam at Captina Island.	Oct. 31, 1885	Aug. 31, 1886	Extended to Dec. 1, 1886, and completed.
Do	Dam at Fish Creek Island.	Oct. 31, 1885	Aug. 31, 1886	Extended to June 30, 1887, and completed.
John F. King	Dam at Three Brothers' Island.	Oct. 23, 1884	Dec. 31, 1885	Extended to Dec. 31, 1886, and completed.
John C. Graham	Dike at Sand Creek Bar.	Oct. 27, 1884	Dec. 31, 1885	Extended to June 30, 1887, and completed.
John J. Shipman	Dike at Eight Mile Bar.	Nov. 28, 1884	Dec. 31, 1885	Extended to Dec. 1, 1886, and completed.
Do	Dike at Four Mile Bar.	Nov. 28, 1884	Dec. 31, 1885	Extended to July 1, 1887.
Kirk & Co	Dike at Rising Sun Bar.	Oct. 28, 1884	Dec. 31, 1886	Completed.
I. V. Hoag, jr	Dike at Grand Chain.	Dec. 1, 1884	Dec. 31, 1885	Extended to Dec. 1, 1887.
John G. Fritsch	Wrecking hook for snag-boat.	June 9, 1886	July 8, 1886	Extended to Sept. 30, 1886, and completed.
N. W. Tucker	Placing riprap stone at Davis Island Dam.	July 15, 1886	Oct. 15, 1886	Abandoned. Stone purchased in open market.
John F. King & Bro	Decked flat-boat for use with dredges.	Sept. 29, 1886	Oct. 1, 1886	Extended to Nov. 10, 1886, and completed.
Fulton Tow-boat Company.	Tow-boat for service with dredges.	Sept. 29, 1886	Dec. 31, 1886	Completed.
James S. Routh	Crib-work at Davis Island Dam.	Oct. 26, 1886	Dec. 31, 1886	Extended to Apr. 23, 1887, and completed.
F. Gwinner	Grading and paving at Davis Island Dam.	Oct. 27, 1886	Dec. 31, 1886	Extended to Aug. 31, 1887.
Crescent City Wrecking Company.	Removing rocks at Grand Chain.	Dec. 6, 1886	Dec. 31, 1887	
John G. Fritsch	Gate engines for operating gates, Davis Island Dam.	Mar. 4, 1887	May 3, 1887	Extended to May 23, 1887, and completed.
Stephen D. Davis	Tow-boat for service with dredges.	May 31, 1887	Dec. 31, 1887	

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COMMERCIAL STATISTICS.

Coal shipments from Pittsburgh, by Ohio River, during the fiscal year ending June 30, 1887, prepared by Capt. William Evans.

Date.	To Cincinnati.				Bushels.	To Louisville.				Bushels.
	Trips.	Coal boats.	Coal barges.	Fuel flats.		Trips.	Coal boats.	Coal barges.	Fuel flats.	
1886.										
July										
August	14	12	128	5	1,810,000	4		48	2	584,000
September	1			5	40,000					
October										
November	51	30	481	29	6,814,000	54	239	356	47	10,236,000
December	22	6	253		3,036,000	28	122	161	13	5,033,000
1887.										
January	14	2	172	5	2,149,000	25	114	145	22	4,590,000
February	15	15	153	5	2,250,000	25	110	142	32	4,696,000
March	21	16	235	4	3,214,000	30	91	230	9	5,041,000
April	39	15	441	6	5,704,000	55	258	334	41	11,015,000
May	23	9	271	5	3,586,000	32	128	225	34	6,057,000
June	23	14	267	3	3,562,000	27	82	213	16	4,575,000
Total	223	119	2,401	67	32,165,000	280	1,144	1,854	216	51,827,000
Grand total										83,992,000

Col. Sidney D. Maxwell, superintendent of the Cincinnati Chamber of Commerce, in his last annual report gives a full exhibit of the river commerce of Cincinnati, from which the following tables, showing the principal items, have been compiled:

River commerce of Cincinnati for the year ending August 31, 1886.

Articles.	Receipts.	Shipments.			
		To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Alcohol ..... barrels			66	117	183
Ale, beer, and porter ..... do		945	1,881	9,750	12,576
Apples, green ..... do	82,262	1,088	12,697	922	96,969
Beans ..... bushels		208	974	1,388	2,570
Beef ..... pounds		238,050	18,150	4,510	260,710
Boots and shoes ..... cases		165	11,456	11,324	22,945
Bran, middlings, etc ..... tons		3	37	321	361
Broom-corn ..... pounds			1,250	47,980	49,230
Butter ..... tubs, firkins, etc		79	158	33	270
Candles ..... boxes		612	962	976	2,550
Castings ..... tons		368	425	193	986
Cattle ..... head	15,371	140	910	319	16,740
Cement and plaster ..... barrels	32,074	130	1,899	21,128	55,231
Cheese ..... boxes		68	2,187	4,176	6,431
Cider ..... barrels		377	597	137	1,111
Coffee ..... bags		38	8,666	12,902	21,606
Cooperage ..... pieces		8,678	490	212	9,380
Corn ..... bushels	120,005	18	5,286	30,363	155,772
Corn meal ..... barrels		44	281	1,051	1,376
Cotton ..... bales	74,102	21	660	2,587	77,370
Crockery ..... packages		1,662	1,919	1,178	4,759
Eggs ..... cases and barrels	43,173		36	280	316
Fish ..... barrels		35	2,200	464	2,699
Fish ..... kegs and kits		292	5,898	1,846	8,043
Flour ..... barrels	4,508	1,277	7,851	41,213	54,808
Fruit, dried ..... bushels		97	1,138	1,781	3,016
Furniture ..... packages		4,908	11,691	10,244	26,843
Glass, window ..... boxes		1,440	2,583	716	4,739
Glassware ..... packages		10,903	31,266	5,809	48,038
Hardware ..... do		1,008	39,912	17,313	58,233

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River commerce of Cincinnati for the year ending August 31, 1886—Continued.

Articles.	Receipts.	Shipments.			
		To New Orleans.	To other down-river ports.	To up-river ports.	Total.
Hay.....bales..	21,843	412	83	8,205	30,543
Hides.....number..	.....	.....	1,460	9,510	10,970
Hog product:					
Bacon.....pounds..	.....	83,370	506,280	3,399,810	3,989,460
Bulk.....do....	.....	10,500	90,250	755,080	855,830
Hams.....do....	.....	443,340	129,880	478,825	1,052,045
Lard.....do....	.....	21,450	451,916	852,340	1,325,706
Pork.....barrels..	.....	813	134	541	1,488
Hogs.....head..	39,585	12	1,031	7,940	48,568
Horses.....do....	.....	102	416	567	1,105
Iron and steel.....tons..	.....	827	3,867	282	4,976
Iron:					
Manufactured.....do....	6,398	.....	.....	.....	6,398
Pig.....do....	11,211	.....	532	503	12,246
Lead, white.....pounds..	.....	7,775	210,430	231,485	449,690
Leather.....bundles..	.....	6	770	1,847	2,623
Lemons.....boxes..	.....	.....	294	576	870
Lime.....barrels..	.....	.....	1,349	9,259	10,608
Malt.....bushels..	.....	.....	21,251	8,833	30,084
Manufactures.....pieces..	.....	2,975	1,209	374	4,558
Merchandise, sundry.....tons..	.....	3,449	12,261	9,107	24,817
Molasses.....barrels..	22,936	25	2,419	2,935	28,315
Nails.....kegs..	365,080	37,217	165,752	1,815	569,864
Naval stores.....barrels..	.....	.....	58	259	317
Oats.....bushels..	.....	6,302	2,416	2,390	11,108
Oil.....barrels..	33,229	741	3,284	4,894	42,148
Onions.....barrels and sacks..	.....	90	387	252	729
Peanuts.....bags..	56,479	161	913	4,627	62,180
Petroleum.....barrels..	9,393	2,684	12,703	1,056	25,836
Potatoes.....do....	19,280	2,016	2,005	9,269	33,470
Rope, twine, etc.....packages..	.....	135	8,591	2,198	10,924
Rye.....bushels..	.....	.....	11,588	3,541	15,129
Salt.....barrels..	164,208	800	53,227	586	218,321
Seed, grass.....bags..	.....	47	2,434	8,668	11,149
Sheep.....head..	34,730	.....	.....	45	34,775
Soap.....boxes..	.....	24,008	22,403	10,556	56,967
Starch.....do....	.....	22,240	15,292	8,196	45,728
Sugar.....hogsheads..	1,816	.....	32	24	1,872
Sugar.....barrels..	2,653	5	7,536	9,050	19,244
Tobacco:					
Leaf.....hogsheads..	24,616	544	2,016	158	27,334
Leaf.....cases and bales..	.....	9	577	352	938
Manufactured.....packages..	.....	78	3,831	8,337	12,246
Vinegar.....barrels..	.....	1,725	4,195	3,208	9,128
Wheat.....bushels..	132,574	.....	6,590	33,322	172,486
Whisky.....barrels..	37,795	2,956	5,266	8,126	54,143
Wine and liquors.....do....	.....	241	230	253	724
Wine and liquors.....baskets and boxes..	.....	566	1,603	1,588	3,677
Wool.....bales..	.....	.....	361	1,842	2,203

Schedule of rates on flour per barrel, by rail or river, from Cincinnati, during the calendar year 1886.

How transported.	Pittsburgh.	Louisville.	New Orleans.
	Cents.	*Cents.*	*Cents.*
By rail	26 to 31	15	44
By river	15 to 20	15	35 to 39

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The following table, compiled from Colonel Maxwell's report, furnishes some additional information regarding the steamboat interests of Cincinnati:

Arrivals and departures of steam-boats at the port of Cincinnati, Ohio.

Ports of departure and destination.	1880–'81.		1881–'82.		1882–'83.		1883–'84.		1884–'85.		1885–'86.	
	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.	Arrivals.	Departures.
From New Orleans	86	.....	68	.....	94	.....	63	.....	49	.....	63	.....
For New Orleans	.....	90	.....	79	.....	95	.....	70	.....	55	.....	66
From Pittsburgh	164	.....	169	.....	147	.....	114	.....	83	.....	103	.....
For Pittsburgh	.....	164	.....	164	.....	143	.....	111	.....	87	.....	103
From Saint Louis	42	.....	38	.....	10	.....	2	.....	.....	.....	.....	.....
For Saint Louis	.....	48	.....	45	.....	16	.....	3	.....	.....	.....	.....
From other ports	2,346	.....	2,461	.....	2,089	.....	1,991	.....	2,005	.....	2,323	.....
For other ports	.....	2,231	.....	2,451	.....	2,075	.....	1,978	.....	1,996	.....	2,314
Total	2,638	2,533	2,736	2,739	2,340	2,329	2,170	2,162	2,137	2,138	2,489	2,483

I am indebted to Maj. Amos Stickney, United States Engineers, for the following statement of commerce passing the Falls of the Ohio, as recorded in the office of the Louisville and Portland Canal:

Commerce passing the Falls of the Ohio River, by canal and by river.

Years.	Through canal.		Descending open river.		Ascending open river.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1880–'81	4,196	1,124,836	1,220	377,055	503	140,306	5,919	1,642,199
1881–'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882–'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883–'84	4,346	1,070,650	1,884	432,575	801	98,757	6,031	1,602,982
1884–'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885–'86	5,057	1,254,342	1,296	408,619	393	102,536	6,726	1,765,497
1886–'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731

LETTER OF MR. S. F. COVINGTON.

OFFICE GLOBE INSURANCE COMPANY,
No. 68 WEST THIRD STREET,
Cincinnati, December 24, 1886.

DEAR SIR: In answer to your inquiry as to "the effect, if any, of the work of improving the Ohio River upon rates of freight and insurance, and also upon the rates of competing routes of transportation," I will have to answer in a general way.

The navigation of the river has been greatly improved by the Government work done upon it. A great many obstructions have been removed, and in many shoal places the channel has been made deeper. The removal of obstructions has made the navigation safer, and of course insurance can be afforded cheaper. The deepening of channels not only enables the boats to carry heavier cargoes, but removes the causes of hinderances and delays, all of which has a strong influence upon the rates of freights.

With navigation made safe by the removal of obstructions, and more reliable as to transmission by the deepening of shoals in times of low water, a powerful influence is exerted upon the rates of competing routes of transportation. It is the facility of transportation by the Ohio River that enables the commerce of the Ohio valley to bring its productions, agricultural, manufacturing, and mineral, to market at prices favorable to both seller and buyer. Continued improvements of the navigation of that river would confer additional benefits upon the commerce of the Ohio valley.

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The resources of the Ohio valley are unlimited, and the commerce, which is already great, will, in a few years, demand the fullest line of improvements upon the Ohio River to meet its requirements.

Respectfully yours,

S. F. COVINGTON.

Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

LETTER OF THE PRESIDENT OF THE LOUISVILLE AND EVANSVILLE PACKET COMPANY.

Office of Louisville and Evansville Mail Company, Nos. 146 and 148, Fourth street, between Main and River.

LOUISVILLE, KY., *July* 26, 1886

DEAR SIR: Since writing you that I could only give you the record for five years back, I have examined all the old records I could find for forty years, back to the time my father started on the river on the steamer *Talma*, and think, from all the information I could collect, you will find this about correct. It shows four hundred and forty days lost by ice in forty years, or an average of eleven days in each year. As I said to you in my last, we have never missed, for the past ten years, on account of low water, more than an occasional day or two by boats grounding.

At first I was afraid to commit myself for more than five years back, as it looked like up hill business, and my apology for this delay is time it took to hunt up the information. I hope it is what you want, and will be of some service.

With kind regards, yours truly,

W. W. HITE.

Col. WM. E. MERRILL.

Table showing the number of days navigation was suspended on the Ohio River between Louisville and Evansville, by reason of ice, during twenty years ending with the winter of 1885–'86.

Winter of—	Days.	Winter of—	Days.	Winter of—	Days.
1847–'48	10	1871–'72	35	1883	6
1851–'52	42	1872–'73	21	1884	22
1853–'54	12	1874–'75	42	1885–'86	19
1855–'56	61	1876–'77	35		
1856–'57	49	1878–'79	30	Total days lost by ice	440
1870–'71	21	1880–'81	35		

LETTER OF THE PRESIDENT OF THE EVANSVILLE, PADUCAH, AND CAIRO PACKET COMPANY.

EVANSVILLE, INDIANA, *July* 17, 1886.

DEAR SIR: Since 1876 the boats of this line have been prevented from running by ice for an average of thirty days in each year. The boats have been delayed by low water, but have never been prevented from making their regular trips by low water during the period you name.

Yours, truly,

F. HOPKINS,
President and Superintendent.

Col. W. E. MERRILL.

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C C 2.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER.

This work remains under the local charge of Mr. William Martin, C. E., to whose skill and intelligence I am greatly indebted for the gradual perfection of detail which has brought this great work into efficient operation. From the beginning there has been no serious difficulty with the dam. It is true that on account of its magnitude it became necessary to substitute steam-power for man-power for maneuvering the wickets, and there has been more trouble from drift and floating débris than could have been anticipated, but nothing has occurred to throw any doubts on the adaptability of movable dams to the conditions that prevail on the Ohio River. A great deal of annoyance and expense has been occasioned by the defective character of the cast-steel cross-heads of the wicket-horses of the navigable pass, which have proved no better than pot-metal, and have sometimes let go under the static pressure of the pool; they were obtained from the Eureka Cast-Steel Company, of Chester, Pennsylvania. That the trouble is due to defective material is readily proven from the fact that similar cross-heads on the weirs have never broken; the latter were furnished under another contract, with the Pittsburgh Steel Casting Company, of Pittsburgh.

The annoyance from floating logs and other drift is so great, and so much time and labor are required for getting them out of the way, that it is considered essential to make a drift-gap in the dam. It is proposed to place this gap on the north side of Pier 2, to make it from 40 to 60 feet wide, and to close it by a bear-trap gate. The space required for the drift-gap will be taken from Weir 1; Pier 1 will be removed, and the remainder of Weir 1 will be added to the navigable pass, increasing its width to over 700 feet. An allotment of $20,000 for this work was contained in the last river and harbor bill, and had that bill become a law, this addition would now be in process of construction. An estimate for this sum will be found in the general report on the improvement of the Ohio River.

The lock of the Davis Island Dam is the widest in the world (110 feet), its great width being unavoidable, as the necessities of the case required the passage, in one lockage, of the ordinary coal fleet of ten barges. This width compelled the adoption of a roller gate, and as gates of this class had never before been used for river navigation, a special type of gate with special apparatus for handling had to be devised. As might have been expected, both gates and apparatus developed many weak points that had to be strengthened, and greater power had to be used on the apparatus for moving. These difficulties, however, have been overcome, and the lock is now in excellent working order. The hydraulic machinery has been replaced by steam-engines and natural gas has been brought to the lock for use in generating steam and for heating purposes in the lock-house.

During the year the additional crib-work of the abutment of the back dam, and the ramp behind this abutment, have been completed, and the terreplein of the lock has been paved, except about 300 square feet, which will be finished before this report reaches Congress. Work on the abutment and on the paving has been under allotments from the general fund for improving the Ohio River, and not from the indefinite appropriation for "operating and care" from which all other expenses were met.

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During the year the movable dam was up 123 days, and 572 lockages were made, passing 1,802 boats, an average of more than 3 boats to a lockage.

For further details reference is made to the annexed report of the resident engineer.

Detailed statement of expenses incurred at Davis Island Dam for the fiscal year ending June 30, 1887.

Date.	Office and general administration.				New machinery.	Repairs.				Grand total.
	Salaries regular force.	Supplies.	Contingencies.	Total.		Labor.	Materials.	Tools and appliances.	Total.	
1886.										
July	$465.00	$67.90	$16.80	$549.70	.....	$336.95	$304.21	$27.72	$668.88	$1,218.58
August	465.00	28.20	53.50	546.70	.....	1,205.61	1,981.10	6.75	3,193.46	3,740.16
September	462.34	0.75	.....	463.09	.....	495.65	20.01	97.00	612.66	1,075.75
October	465.00	59.50	24.00	548.50	.....	49.90	23.97	171.65	245.52	794.02
November	465.00	5.20	6.26	476.46	$600.00	28.07	101.55	.....	129.62	1,206 08
December	465.00	61.40	170.88	697.28	12.00	347.55	209.65	7.08	564.28	1,273.56
1887.										
January	465.00	29.25	2.00	496.25	375.00	.....	5.50	.....	5.50	876.75
February	465.00	12.37	104.00	581.37	.....	.....	.....	.....	.....	581.37
March	465.00	4.85	46.40	516.25	.....	.....	57.11	5.25	62.36	578.61
April	465.00	29.03	5.70	499.73	.....	42.80	144.94	11.25	198.99	698.72
May	443.67	15.13	8.80	467.60	2,994.92	270.77	144.96	52 89	468.62	3,931.14
June	425.00	43.11	.....	468.11	.....	195.00	.....	.....	195.00	663.11
Total	5,516.01	356.69	438.34	3,311.04	3,981.92	2,972.30	2,993.00	379.59	6,344 89	16,637.85

Approximate estimate of the cost of operating and maintaining the Davis Island Dam, Ohio River, for the fiscal year ending June 30, 1888.

Salaries	$7,430
Natural gas	193
Supplies, rope, oil, etc	124
Rubber diving dress	40
Repairs	450
Telephone service	240
Water-gauge reports	70
Post-office box rent	8
Store-house and workshop	500
Riprap below dam	2,000
Removal of Pier 1	300
Contingencies	1,000
	12,355

REPORT OF WILLIAM MARTIN, ASSISTANT ENGINEER.

SIR: I have the honor to submit the following report of operations on the Ohio River at Davis Island Dam, 5½ miles below Pittsburgh, Pa., for the year ending June 30, 1887:

Back River Dam.—The work of extending the crib-work of the shore abutment of the dam behind Davis Island, and of constructing a ramp behind this abutment, has been completed under contract with James S. Routh, dated October 26, 1886. Work under this contract was begun October 29, but was much delayed by frequent rises in the river, which prevented the excavation for the foundation of the crib-work, and also by the non-delivery of material, so that it became necessary to extend the

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contract. Work was resumed this spring as soon as the stage of water would permit, and was fully completed, and the contract closed on April 23.

Terre-plein of lock.—The work of filling and paving the area behind the land wall of the lock, and between the gate recesses, has been nearly completed under contract with F. Gwinner, dated October 27, 1886. All the earth filling was completed by January 1, 1887, but, as the ground was frozen, it was considered unadvisable to pave the surface until the earth had become thoroughly settled. The paving was begun in the spring, as soon as the condition of the ground would permit, and at the close of the fiscal year was complete, with the exception of about 300 square feet.

The defective steel cross-heads of the horses in the navigable pass have continued to give great annoyance, it having been necessary to replace 20 of these cross-heads by new ones of wrought iron. At the close of the year 12 additional cross-heads are found to be broken, and must be replaced at once. It is recommeded that, as soon as practicable, all of the cross-heads in this pass which have not already been replaced be removed, and new ones of wrought-iron be substituted, as the existence of this defective material in the structure is not only a menace to its stability, but makes the operation of maneuvering the wickets one of great danger to the employés. The following incident will serve to illustrate this point: On the morning of June 30, while one of the men was employed above the dam with a skiff opposite Wicket No. 51, the cross-head of this wicket broke, and the skiff was dashed over the dam, but the man saved himself by getting on an adjacent wicket. Three other men were at work at the time below the dam, but fortunately were two wickets distant from No. 51, otherwise they would inevitably have been crushed by the falling wicket. Occurrences like this render the men very timid about performing their duties when the dam is up. The defective cross-heads were cast by the Eureka Cast-steel Company, of Chester, Pa.

The pump in the river wall for supplying water for opening and closing the filling and discharging valves of the lock has given considerable trouble by breaking down on several occasions. The stroke of this pump, which is driven by a 25-inch turbine, has been shortened from 24 inches to 12 inches, thus reducing the strain on the machinery, and rendering its operation quite satisfactory.

The wheels of the lower lock-gate began breaking about the middle of July, and by the end of the month it was impossible to operate this gate; the dam was accordingly lowered on the 2d of August to permit the necessary repairs. In order to remove the broken wheels and put in new ones, it was necessary to inclose the gate by a coffer-dam; this was done, and wheels of a much stronger pattern were placed under the gates, so that no further trouble is anticipated from this source. The work was completed and the dam was again raised on September 1.

The chain for operating the lower lock-gate, having proved of insufficient strength, has been replaced by a heavier chain.

The Chanoine Dam at the head of the lock is composed of 27 wickets, and was built in order to stop the current through the lock so as to permit both lock-gates to be opened when the dam is down. As there is a fall of 9 inches in the length of the lock at the 6-foot stage in the open river, it was uncertain whether or not both lock-gates could be withdrawn with this head of 9 inches against the last one. Experience, however, has shown that by opening all the valves in the lower-lock gate and the gate recess, the head in question is so far reduced that the operation can be performed in safety, and that as a rule it is not necessary to raise the dam across the head of the lock. In case of ice or drift, or of an accident to the gates, it will still serve a useful purpose.

Our experience having shown that the physical labor of handling the large number of wickets at the Davis Island Dam was exhausting to the lock force, a steam engine was procured for this purpose, and as the maneuvering boat which had been built with a view of operating the wickets by hand power was of insufficient size for carrying the steam machinery, this engine was mounted on a flat-boat, 16 by 40 feet, to which all the other apparatus for handling the dam has been added. This new maneuvering boat gives great satisfaction, and the hand-power boat is now utilized for carrying the needles used in closing the spaces between the wickets, and for general service about the dam.

After an experience of eighteen months with the hydraulic machinery for operating the lock-gates, it was decided to abandon the hydraulic method, which had proven inefficient and unsatisfactory, and adopt steam power. To this end a contract was entered into on March 3, 1887, with John G. Fritsch, of Cincinnati, Ohio, for two portable engines, one for each gate. Each of these engines is mounted on a bed-plate, supported by trucks, which permits its removal in times of flood by means of a tramway leading to high ground. The hydraulic machinery was taken out of the wells, and the engines were connected by suitable gearing to the drum shafts for operating the gates; this gearing is so arranged that the engines can be readily detached for removal whenever it becomes necessary.

The annoyance caused by the accumulation of drift above the service bridge and the wickets has not lessened with this year's experience. Large quantities of drift,

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frequently containing logs and trees of formidable size, are carried into the river from the small tributaries at each flood, and it often requires the constant labor of the entire force to get rid of this obstruction. The amount of such material has been greatly increased by the general use of natural gas in the cities of Pittsburgh and Allegheny, in consequence of which a vast quantity of refuse that was formerly burned is now thrown into the river. It seems absolutely essential that some sort of chute be made through the dam in order to pass floating objects down the river, and prevent their getting entangled among the wickets and trestles.

On the morning of June 8, on a rapidly-rising river, the drift-wood accumulated in such quantities above the service bridge as to make it impossible to lower it. When the stage of water reached 13 feet, the weight of this material was so great as to crush the bridge above Weir 1, thus necessitating its entire removal from the river. The wickets of this weir will hereafter be operated, like those of the navigable pass, by means of the maneuvering boat.

The introduction of natural gas for generating steam for the lock-gate engines has greatly facilitated the work of operating the lock, as but a few minutes time is now required to raise steam to any desired pressure, so that the gates can be handled rapidly and boats can be passed through the lock without unreasonable loss of time. Natural gas is also used in connection with the engine for pumping water to the tanks when the dam is down and there is no head for running the turbine in the river-wall of the lock, and also for heating purposes in the lock-keeper's house.

The movable dam has been up one hundred and twenty-three days during the year, viz:

	Days.
From July 1 to August 2	33
From September 1 to November 14	75
From April 7 to April 18	12
From June 28 to June 30	3
Total	123

The following is a statement of commerce passing the dam during the year:

Vessels passing the Davis Island Dam.	Through navigable pass.	Through lock.
Passenger-boats	414	55
Freight-boats	83	9
Tow-boats	3,385	590
Model barges	306	14
Coal-boats	1,520	42
Coal barges	8,141	451
Coal-flats	3,339	667
Rafts	53	7
Miscellaneous craft	95	67
Total	17,317	1,902

The total number of lockages was 572.

Respectfully submitted,

WILLIAM MARTIN,
Assistant Engineer.

To Lieut. Col. WM. E. MERRILL,
Corps of Engineers, U. S. A.

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CC 3.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

The river and harbor act approved August 5, 1886, contained the following:

Improving Monongahela River, Pennsylvania and West Virginia: Continuing improvement, $90,000; but no charges or tolls shall be collected on any other part of the river on any commerce on said river which originates above the works herein appropriated for.

In submitting a project for the application of this appropriation, Lieutenant Beach called attention to the phraseology of the act, and requested an official interpretation as to its effect on the expenditure of the appropriation. The honorable Attorney-General gave an opinion that the phraseology in question would not interfere with work under the appropriation, but this opinion was not received until the middle of October, and, as it was then near the close of the season, work was necessarily postponed until the season of 1887.

Operations were resumed on the 18th of April under the direction of Mr. P. J. Schopp, C. E., and at the close of the fiscal year the river-wall was completed to an average height of 14 feet above the lower miter sill, lacking 12 feet of its intended height. The land-wall and the lower wing-wall have been built to a height of 11 feet above the miter-sill, but the wing-wall lacks 30 feet of its ultimate height. Work was much embarrassed in May and June by high water, but at the close of the year the walls were out of the reach of ordinary summer floods.

Work on the abutment will be begun in July, and it is expected that by the close of the season all masonry work will be completed, leaving only the dam and the lock-gates and machinery for the season of 1888.

ESTIMATE.

The amount yet required to complete this work, according to my estimate of last year, is $30,376. Inasmuch as the work has been delayed a year longer than was then expected, it is proper to increase this estimate to $35,000, in order to cover depreciation of plant and additional cost of administration.

Money statement.

July 1, 1886, amount available	$3,436.96	
Amount appropriated by act approved August 5, 1886	90,900.00	
		94,336.96
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$5,776.91	
July 1, 1887, outstanding liabilities	4,464.79	
		10,241.70
July 1, 1887, amount available		84,095.26

Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Lock No. 9 is still without connection with the slackwater system on the lower river, and the business done through it is small compared to what is expected upon the completion of No. 8.

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The commerce at No. 9 during the past year was as follows:

Commerce passing Lock No. 9, Monongahela River, during the fiscal year ending June 30, 1887.

Date.	Lockages.	Up.				Down.						
		Steamboats.	Barges and flats.	Miscellaneous.	Merchandise.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.	Merchandise.	Lumber.	Timber.
1886.					*Tons.*					*Tons.*	*Ft., B. M.*	*Cub. ft.*
July	38	.....	3	13	26	.....	4	.....	16	7	.....	.....
August	24	.....	6	3	30	.....	5	2	8	.....	25,000	8,000
September	14	.....	4	4	27	.....	4	.....	2	2	3,500	.....
October	6	.....	1	.....	24	.....	1	.....	1	.....	.....	.....
November	11	.....	1	1	21	.....	4	6	1	1	7,000	18,000
December	3	2	.....	.....	25	.....	.....	.....	.....	2	.....	.....
1887.												
January	2	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....
February	10	1	1	1	26	1	2	3	1	.....	.....	11,000
March	37	.....	5	3	46	.....	5	23	4	16	120,000	78,000
April	62	.....	2	12	9	.....	2	55	12	4	388,000	95,400
May	55	.....	4	20	18	.....	3	12	25	.....	54,000	.....
June	54	.....	4	13	47	.....	5	23	12	.....	45,000	60,500
Total	316	3	31	71	299	1	35	124	83	32	642,500	299,900

The following statistics, taken from the annual reports of the Monongahela Navigation Company, show the commercial movements on the lower or northern end of the river for four years, ending December 31, 1886.

Articles.	1883.	1884.	1885.	1886.
Brick ..... number..	1,866,161	652,126	588,892	3,998,802
Cattle and horses ..... do....	766	289	998	1,029
Classified freight ..... pounds..	35,179,470	27,779,991	27,365,266	26,171,201
Coal, coke, and slack ..... bushels..	112,395,389	81,706,852	85,923,107	113,099,147
Fire-clay ..... tons..	5,794	2,140	3,463	3,295
Hogs ..... number..	.....	3,381	1,845	1,105
Iron ore ..... tons..	31,681	20,840	16,486	17,823
Iron in pigs ..... do....	785	17	11½	5
Lumber ..... feet..	11,759,890	7,142,447	6,414,212	6,820,804
Oil ..... barrels..	1,479	52	1,073	.....
Pipe ..... tons..	.....	.....	595	.....
Posts ..... number..	2,800	255	12,826	21,853
Posts, pit ..... do....	252,905	219,200	201,040	114,950
Railroad ties ..... do	57,000	16,750	1,800	2,150
Sand ..... bushels..	733,700	679,000	941,300	1,076,900
Sheep ..... number..	.....	5,677	4,464	3,600
Sheep and hogs ..... do....	11,017	.....	.....	.....
Staves ..... do....	135,000	.....	4,000	4,000
Steel rails ..... tons..	43,946	23,844	22,428	45,795
Stone ..... perches..	15,635	32,067	4,350	2,641
Timber ..... feet..	3,635,624	2,091,740	2,052,100	2,342,146
Whiskey ..... barrels..	5,719	6,770	5,293	4,374
Wood ..... cords..	32	.....	120	102
Passengers ..... number..	26,058	26,871	24,698	26,885

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REPORT UPON THE COMMERCIAL VALUE AND IMPORTANCE OF THE WORKS OF THE MONONGAHELA NAVIGATION COMPANY.

REPORT OF BOARD OF ENGINEERS.

PITTSBURGH, PA., *December* 21, 1886.

GENERAL: The act of Congress approved August 5, 1886, contains the following:

The Secretary of War is hereby authorized and directed to ascertain the value and commercial importance of the works and property * * * of the Monongahela Navigation Company, situated on the Monongahela River, in the State of Pennsylvania; and in order to acquire such information the Secretary of War shall appoint a Board of three competent engineers from the Engineer Corps of the United States Army, which Board shall * * * report to the Secretary of War, who shall report thereon to Congress at its next succeeding session; and the cost of such examination shall be paid out of the sum appropriated by this act for surveys: *Provided*, That nothing herein shall be construed as committing Congress to the purchase of the said works.

By direction of the Secretary of War, a Board of Engineers, consisting of Col. James C. Duane, Maj. William R. King, and Maj. Alexander Mackenzie, Corps of Engineers, was constituted by Special Order No. 112, dated Headquarters Corps of Engineers, United States Army, Washington, D. C., August 13, 1886, to consider and report upon the questions referred to in the foregoing act of Congress.

By letter of the Chief of Engineers, dated October 18, 1886, Maj. Amos Stickney, Corps of Engineers, was detailed as a member of the Board, *vice* Colonel Duane, who was relieved in consequence of his appointment as Brigadier-General and Chief of Engineers, United States Army.

A preliminary meeting of the Board was held at Cincinnati, Ohio, on the 22d, 23d, and 24th of September, 1886. After organization, the following instructions from the Chief of Engineers were considered:

It is desired that the Board avail itself of all attainable information upon the subjects upon which it is required to report, and to this end it will visit the localities, hold public meetings, giving due notice thereof through the newspapers, or otherwise, as may appear best, invite discussion, orally or in writing, and, in brief, use every effort to inform itself in regard to the origin of the works, respectively, the means provided for their construction and their cost; also in reference to their present and prospective value to the interests of the commerce and navigation likely to be promoted by their acquisition and improvement by the Government, with the view of making the reports full, complete, and exhaustive, and to this end every avenue of information should be pursued to its source.

It is suggested in this connection that Lieut. Col. William E. Merrill and Capt. James C. Post, Corps of Engineers, may be able to furnish from the records of their offices valuable data in reference to the works specified in the act, and the Board is authorized to call upon them accordingly.

For the purpose of securing all available information the following circular letter was prepared and distributed:

DEAR SIR: * * * In accordance with the above provision of law the Secretary of War has appointed a Board of Engineers, consisting of Col. James C. Duane, Maj. William R. King, and Maj. Alexander Mackenzie, to examine and report upon the * * * Monongahela River.

It is the desire of this Board to collect all available information relating to the commercial importance, present and prospective, of the river under consideration, and such facts as may assist in forming a proper estimate of the present value * * * of the locks and dams of the Monongahela Navigation Company, on the Monongahela River, between Pittsburgh and the State line.

You are respectfully invited to submit, at your earliest convenience, any information or suggestions which, in your opinion, have any bearing on the question before the Board.

* * * * * * *

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On September 21 and December 6 and 7, 1886, members of the Board made examinations of the works on the Monongahela River.

On December 18, 19, 20, and 21, 1886, the Board held sessions in Pittsburgh, the meeting of the 20th being a public one, in accordance with due notice given. At the public meeting all parties desiring to appear were accorded an opportunity to do so, and the Monongahela Navigation Company, the Pittsburgh Coal Exchange, and other interests were represented.

Much of the detailed information needed in connection with an investigation of matters upon which the opinion of the Board is desired has necessarily been obtained from the full and complete records and reports of the Monongahela Navigation Company; and while the powers of the Board have only permitted requests for information, all such requests have been most promptly and cheerfully complied with by the company, and very detailed and complete statistics have been furnished. Great assistance in the investigation has been given by members of the Coal Exchange of Pittsburgh and representatives of other interests affected by the conditions under which the navigation of the Lower Monongahela is now carried on. The information furnished the Board is submitted as appendices.

The Monongahela River rises in West Virginia, runs through the State of Pennsylvania, and empties into the Ohio at Pittsburgh. Originally the river was unnavigable, excepting at certain stages of water. The valuable resources of the tributary country and advisability of its full development led to the improvement of a portion of the river by a corporation under a charter from the State of Pennsylvania. The improvement has proved a most wise one, and has resulted in building up an immense commerce on the river. But the fact that the work has been carried out by private means and is now in the hands of private parties leads to the collection of tolls and results in a tax on commerce which, it is claimed, affects injuriously certain important interests; and is, in fact, a discrimination against one section of the country and its commerce, placing it at a great disadvantage as compared with other sections, which have had their interests developed by the United States and which are not subjected to tax.

The Monongahela Navigation Company, which built and now operates the works of improvement on the Lower Monongahela River, was incorporated under the provisions of an act of the Pennsylvania legislature approved June 14, 1836. By this act the subscribers to stock were created a company, which was empowered—

> to form and make, erect and set up any dam, locks, or any other device whatsoever which they shall think most fit and convenient to make a complete slack-water navigation between * * * the city of Pittsburgh and the Virginia State line.

The act also regulated tolls, and authorized the leasing of any water-power created, provided for sworn annual reports to the legislature of receipts and disbursements, and required an annual tax to be paid to the Commonwealth. It was also provided that work should be commenced within five years from passage of act, and completed to Virginia State line in seven years thereafter. The time for completion has since been extended. Section 18 of the act provided that the State of Pennsylvania may, at the end of twenty-five years from completion, purchase the work. Section 20 prohibited the Navigation Company from engaging, directly or indirectly, in river transportation or other business enterprises.

Since the organization of the company, thirty-three acts affecting it have been passed by the Pennsylvania legislature. Copies of these acts

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are appended, marked Appendix No. 8. The most important of them, so far as this investigation is concerned, appear to be as follows:

An act of June 24, 1839, provided that all locks below Elizabeth and Brownsville should be 190 feet long and 50 feet wide; that the company should be entitled to receive such rates of toll, at their discretion, as may be just and reasonable, provided that the net dividends on stock should not exceed 12 per cent. per annum.

Section 8 provided—

> In case the Commonwealth should at any time purchase the improvement made in pursuance of this act and the act to which it is a supplement, then the Commonwealth shall pay to the company such sum or sums of money, as, together with the net dividends, shall amount to the expense incurred in constructing said improvement and keeping the same in repair, with 8 per cent. per annum interest thereon.

The legislature also reserved the right—

> to alter, amend, or annul the charter of said company at any time hereafter, in such manner, however, that no injustice shall be done to the corporation.

This matter was also referred to in section 4, act of March 21, 1849, which provides as follows:

> The legislature reserves the right to alter or amend the charter of said company, at any time hereafter, should they violate, abuse, or misuse the privileges granted and such fact be previously found by the verdict of a jury. * * *

Acts of March 31, 1843, May 4, 1855, and April 8, 1857, extended the time of completing the works, the last date being the time of completion of work for extending slackwater from State line to Morgantown. The work was actually completed in 1884.

An act approved January 25, 1854, authorized the company—

> to issue stock and distribute the same, or the proceeds of the sale thereof, pro rata, amongst the owners of the present stock of the company, to an amount equal to the sum or sums which may have been expended in the construction of their improvement, and which has not heretofore been represented by stock in the company; and also, for such further amount as may hereafter be applied, out of the earnings of the company, towards the construction of the extension hereby authorized, or to the payment of the principal or interest upon any bonds or obligations of debt which have been or may be issued for the construction or extension of said improvement.

In accordance with this authority, there was distributed to the stockholders 15 per cent. of stock in 1867, and 20 per cent. in 1870, and since January, 1884, dividends have been declared in stock instead of cash, the earnings having been used for new construction.

The works of the Monongahela Company consist of four crib-dams with double locks and three dams with single locks. The lifts are about 8 feet at Dams Nos. 1, 2, and 3; 10 feet at No. 4; about 14 feet at Nos. 5 and 6. Dam No. 7 extends slackwater to Dunkard's Creek, the site of the dam now being constructed by the United States. The locks first constructed at Dams 1, 2, 3, and 4, and Locks 5, 6, and 7, are about 190 feet long and 50 feet wide. The additional locks at Dams 1, 2, 3, and 4 are 56 feet in width and from 250 to 312 feet in length.

Locks and Dams Nos. 1 and 2 were completed in 1841; Nos. 3 and 4 in 1844; additional lock No. 1 was built in 1847; No. 2 in 1854. Locks and Dams Nos. 5 and 6 were completed in 1856; No. 7 in 1884. Additional lock No. 3 was completed in 1884, and No. 4 in 1886.

A full description of these locks and dams is given in an appended report made by Mr. Thomas P. Roberts, chief engineer, to M. K. Moorhead, president of the Navigation Company. (Appendix No. 1.)

The present condition of the works, as may be inferred from the great disparity in the ages of the different structures, varies from that of new substantial masonry and timber work to that of works serviceable but

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much worn and dilapidated. Some of the locks will need but little repair for many years to come, while considerable work will soon be needed at others to put them in safe condition.

COMMERCIAL IMPORTANCE.

The commercial importance of the works on the Monongahela River built and owned by the Navigation Company is measured by the importance of the stream, which these works have improved and rendered navigable at all times.

The Monongahela River, rising in West Virginia, running through Pennsylvania, and emptying into the Ohio at Pittsburgh, has tributary to it a rich and well-settled country, of the products of which it is only necessary to consider the article of coal, the immense shipments of which are matters of public record. The item of coal alone, which depends upon the Monongahela for an outlet to the markets of the country, is sufficient in amount to make this stream of great national importance. During the past ten years the shipments of coal and coke from the Monongahela have exceeded 850,000,000 bushels, an average of 85,000,000 bushels per year. During the same time the tolls received by the Monongahela Navigation Company from all sources have amounted to about $2,250,000, an average of $225,000 per year for those years.

From statements furnished the Board it appears there are upwards of 100 tow-boats registered at the port of Pittsburgh and employed in the moving and towing of coal out of the Monongahela River. It is also stated that there are 71 coal mines on the river, the operations of which, including shipments to market, represent cash transactions of not less than $8,000,000 per annum, and give employment to a force of about 15,000 men.

The following table shows the total shipments on Monongahela slackwater during past five years:

Shipments on the Monongahela slackwater in 1881, 1882, 1883, 1884, *and* 1885.

Articles.	1881.	1882.	1883.	1884.	1885.
Brick.....number..	881,400	1,318,175	1,806,161	652,126	588,892
Cattle and horses .....do....	382	528	766	289	998
Classified freight .....pounds..	30,896,050	42,033,389	35,179,470	27,779,991	27,365,266
Cinder .....tons..	.....	6,700	450	.....	.....
Coal, coke, and slack.....bushels..	90,035,360	106,168,300	112,395,389	81,706,852	85,923,107
Fire-clay.....tons..	1,288	4,737	5,794	2,140	3,463
Iron ore.....do....	10,094	23,488	31,681	20,840	16,486
Iron, in pigs .....do...	465	1,132	785	17	12
Lumber .....feet..	10,936,750	8,011,966	11,759,890	7,142,447	6,414,212
Posts.....number..	302,630	17,983	2,800	255	12,526
Posts, pit.....do ...	.....	307,320	252,905	219,200	201,040
Oil .....barrels..	.....	1,727	1,479	52	1,073
Railroad ties.....number..	16,500	182,700	57,000	16,750	1,800
Sand .....bushels..	235,200	541,000	733,700	679,000	941,300
Sheep and hogs .....number..	5 150	10,958	11,017	9,058	6,309
Staves.....do....	5,000	120,000	135,000	.....	4,000
Steel rails .....tons.	21,801	26,308	43,946	23,844	22,428
Stone .....perches..	8,505	12,804	15,635	32,067	4,350
Timber.....feet..	11,272,900	3,622,567	3,635,624	2,091,740	2,052,100
Whisky.....barrels..	3,683	4,443	5,719	6,770	5,293
Wood.....cords..	300	.....	32	.....	120
Passengers..... ....number..	24,282	52,226	26,058	26,871	24,696

Statements of the Navigation Company (Appendix No. 1) and Pittsburgh Chamber of Commerce (Appendix No. 2) furnish many facts bearing upon the commercial importance of the Monongahela River and the existing works of improvement.

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The money value of the commerce on this river is very great, far in excess of that of a majority of the streams upon which the United States Government, under its policy of fostering commerce, has expended millions of dollars in improvements.

The importance of the stream is indicated by the fact that the United States has already undertaken the improvement of the Upper Monongahela in West Virginia by the construction of two locks and dams above the company works; $397,900 has already been appropriated for such work. All the commerce developed in this part of the river by the Government improvements destined for the Lower Monongahela and Ohio must avail itself of the works of the Navigation Company; and, in this connection, the act of August 5, 1866, in appropriating money for the Upper Monongahela, provides that "no charges or tolls shall be collected on any other part of the river on any commerce on said river which originates above the works herein appropriated for."

VALUE OF THE WORKS AND OTHER PROPERTY OF THE MONONGAHELA NAVIGATION COMPANY.

The property of the company consists in certain locks, dams, and appurtenances, and certain vested rights granted to the company by the State of Pennsylvania.

The works have a value to the company which has constructed and now owns them, and the franchise which authorizes the collection of tolls is also valuable. The works are important to the interests of commerce and navigation using them, and through these interests to the General Government, which, ordinarily under the conditions of commerce which here exist, builds and pays for such improvements.

(1) COMBINED VALUE OF WORKS AND OTHER PROPERTY, INCLUDING THE FRANCHISE.

This value is stated by the president of the company in the following language:

> Previous to the recent agitation of the question of the purchase of the improvement by the United States Government the stock of the company sold at a premium of 80 per cent., or $90 per share, and is, in the opinion of the company, now well worth that price, making the present value of the company's improvements, calculated on a basis of 4½ per cent. interest, over $4,000,000.

From affidavits furnished through the company, it appears that stock of company sold in September, 1884, for $100 per share, early in 1886 at $89 per share, and in December, 1886, at $82 per share. Taking the number of shares of capital stock actually issued at the dates given, we obtain the following calculation:

20,093 shares, at $100	$2,009,300
23,893 shares, at $89	2,126,477
26,896 shares, at $82	2,205,472

It is understood that the stock is not commonly bought and sold on the market, and that the above sales were of small lots. These facts and other causes may possibly have resulted in prices which do not definitely fix the value of the works and property to the company. The computation is given to indicate a method rather than positive value.

The law permits the capital stock to be increased as new construction is carried out, and the present amount of capital stock has been so increased since the dates for which calculation is made.

The law also permits dividends of 12 per cent. on the capital stock, and increase of said stock, under certain limits, will, under favorable condi-

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tions of management and repair, result in increase dividends and an increased value of property. But the repairs necessary to keep the works in a serviceable condition are indefinite, and accidents in the future, as in the past, which might cause very large outlays and affect net income, are possible. These uncertainties must affect value of property. As the value of the company property depends on the number of shares of its capital stock and the market value of such stock, both variable quantities, the Board is unable to fix on any amount which properly represents such value at any future time.

(2) VALUE OF THE WORKS (LOCKS, DAMS, AND APPENDAGES) OF COMPANY, EXCLUSIVE OF FRANCHISE.

The construction account, as taken from the treasurer's statement, including cost of locks and dams, land damages, dredging, repairs of damages due to ice and floods, cribs, repair-boats, lock houses and lots, interest on construction bonds, etc., is given as $2,001,206.94 (Appendix No. 5). This amount, together with item of $1,032,324.40 expended for general repairs, gives total outlay by company for construction and repairs $3,033,531.34. The same authority, basing calculation on recent construction, makes the following estimate of value of locks and dams, apart from earning capacity, and not including engineering, land, or any other accessory:

Taking the cost of Lock and Dam No. 7, being $161,733.13, as a basis, we have—

Seven locks and dams, at $162,000	$1,134,000
Additional lock, No. 3	220,000
Three additional locks, at cost of No. 4, $196,000	588,000
Total	1,942,000

From this estimate it is argued by the treasurer that, with all accessories and additional expenses, the works could not be duplicated at the present time for less than from $2,250,000 to $2,500,000.

The chief engineer of the company, in a detailed estimate of cost of building works *de novo*, fixes the value of such works, including all real estate and accessories, at $2,494,700 (Appendix No. 4).

It may be admitted that an estimate of about $2,250,000 for new and substantially built works and accessories (as enumerated) does not appear excessive; but the present question is the valuation of old works, now in use, it is true, but still, in many instances, in need of extensive repairs to make them as good as new. The cost of such repairs in the opinion of the Board is about $300,000, making the present intrinsic value of existing works about $1,950,000.

In fixing the intrinsic value no account has been taken of any enlargement or additional works which might be called for in the event of a transfer to the United States.

(3) VALUATION OF WORKS AND PROPERTY PROVIDED FOR BY THE STATE.

An act of the Pennsylvania legislature which contemplated a purchase of the works and property of the Monongahela Navigation Company provided for a method of estimating value; such value being cost of work and repair, with 8 per cent. interest per annum, less dividends paid. The items of repair and dividends (Appendix No. 5) are given, but construction account not being given by years, a calculation of value on the basis established by the State can not now be made. The date at which such purchase would have been possible by State law,

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under original character, was 1873; but, owing to the several extensions of time for completion, the twenty-five years allotted time for life of grant would date from 1884. It might, however, be practicable, with all details of calculation at hand, to estimate future amounts and determine a present worth of the value as it will be in the year 1909.

From the figures before the Board, it would appear that, up to close of year 1886, there has been expended by the company for construction and repairs, as per books, $3,033,531.34 (see Appendix No. 5). During the same time there has been received from tolls about $5,909,132, and there has been paid to stockholders, in addition to stock dividends, cash dividends amounting to about $2,200,000.

SUMMARY AND CONCLUSIONS.

The commercial importance of the Monongahela River is very great, and the river properly belongs to and should be considered among the important navigable waters of the United States.

At the present time a portion of the river is withdrawn from the fostering care of the General Government by the action of the legislature of the State of Pennsylvania, which has virtually placed the control of a portion of the river in the hands of a private corporation, to which certain vested rights have been granted.

These vested rights, which authorize the collection of tolls by the Monongahela Navigation Company, result in a tax on commerce, not excessive, but still of consequence in the present day of close competition.

The tax on the commerce of this section of the country appears unjust while the avenues to market of competing sections are made free by the Government, as in the case of the Kanawha, and, particularly, of the portion of the Monongahela itself situated above the company's works, the commerce of which passing through the lower portion is relieved from the payment of tolls to the Monongahela Navigation Company by the act of Congress approved August 5, 1886.

The company, now holding vested rights on the river, does not wish to sell or transfer its works and property to the General Government; and the State of Pennsylvania, from which the company's rights are obtained, while providing a method for eventually taking upon itself the control of the portion of river lying in Pennsylvania, has as yet done nothing looking to the assumption of such control by the General Government.

The only methods apparent to the Board by which the General Government can obtain control of the Lower Monongahela are:

(1) By condemnation in the interest of the general public, with such compensation as a proper tribunal may deem just.

(2) By acceptance or purchase of the works from the State of Pennsylvania, after the State shall have properly extinguished the rights of the company and relieved commerce of the tax now imposed as a result of State legislation.

The value of the whole property to the company is placed by them in excess of $4,000,000. Basing calculations on sales of stock and number of shares of capital stock actually issued at time of sales, the value of the works and property of all kinds, including franchise and the assumption of liabilities, would appear to have been $2,009,300 in September, 1884; $2,126,477 early in 1886, and $2,205,472 in December, 1886. The satisfaction of the liabilities would require a sum varying from day to day. This amount at the date of the treasurer's statement was $277,082, which should be added to the $2,205,472, making

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$2,482,554 as an actual valuation, based on the last market sales. A legitimate increase of capital stock which is being made will within certain limits increase the value of the property, but to what extent the Board can not determine. The intrinsic value of the works and appendages, including all items enumerated by the treasurer and chief engineer in their estimates of December 30 and December 29, and *excluding* the franchise or right to take toll, is placed by the Board at $1,950,000, which does not exceed the tax in the form of tolls which commerce would pay, under present control, during the next nine years.

Respectfully submitted,

W. R. KING,
Major of Engineers.
AMOS STICKNEY,
Major of Engineers.
A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDICES.*

1. Letter from the president of the Monongahela Navigation Company, referring to organization of company and value of property, including report of chief engineer descriptive of works; also rates of toll charged.
2. Memorial addressed to Congress by Pittsburgh Chamber of Commerce, relating to commercial importance of Monongahela River, and urgent necessity of making the same a free highway of commerce, and appraisal of works by S. Wainwright, consulting engineer.
3. Affidavits relating to number of shares of stock and value of same.
4. Report of chief engineer of Monongahela Navigation Company, giving estimates of cost of construction of new works and value of accessories.
5. Letters of treasurer of company, giving details of construction account, repairs, dividends, and estimates of present value.
6. Resolution of Louisville Board of Trade.
7. Opinion of the attorneys for Monongahela Navigation Company respecting questions involved.

C C 4.

OPERATING AND CARE OF LOCK AND DAM No. 9, MONONGAHELA RIVER.

During the past fiscal year the ordinary routine of passing boats and rafts proceeded as usual.

In the early part of February there came a sudden flood in the Monongahela River which at 2 a. m. on the 4th had reached a height of 5 feet above the head of the lock, with a fall of 2.7 feet. The current due to this fall had such velocity that it scoured a deep hole behind the upper wing-wall, whose greatest depth was 15 feet and greatest length (back of land wall) was 93 feet. One of the hog chains of the upper arm of the upper gate on the river side was broken, and some slight damage was done to the crib outside of the river wall. The lock chamber received the material washed out from behind the wing-wall, and the working of the gates was temporarily stopped by accumulations of drift.

These damages were promptly repaired under the direction of Mr. William Weston, civil engineer, and the expenses were defrayed out

* Omitted. Printed in House Ex. Doc. No. 112, Forty-ninth Congress, second session.

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of a special allotment of $1,100 from the indefinite appropriation for "operating and care of canals and other works of navigation." Special pains were taken to protect the surface behind the upper wing-wall, and it is believed that such an accident can not occur again.

As there are indications that the bed work on which the dam is built is giving way under the effects of the overfall, it is proposed during the present fiscal year to extend the apron built below a portion of the dam in 1884 until the whole length of the work is provided with an apron. It is expected that the effect of this apron will be to destroy the reaction below the dam, and to push the area of excessive scour so far from the dam that the bed-rock shall be secure from future attack.

ESTIMATE FOR YEAR ENDING JUNE 30, 1888.

Addition of apron to dam	$10,000
Lock-keeper's salary	600
Contingencies	400
	11,000

Statement of expenses incurred on Lock and Dam No. 9, Monongahela River, during the fiscal year ending June 30, 1887.

Date.	General administration.			Equipment.	Repairs.				Grand total.
	Salary of lock-keeper.	Contingent expenses.	Total.		Labor.	Material.	Freight.	Total.	
1886.									
July	$50.00	.....	$50.00	.....	$20.55	$39.69	.....	$60.24	$110.24
August	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
September	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
October	50.00	.....	50.00	.....	.....	36.10	.....	36.10	86.10
November	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
December	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
1887.									
January	50.00	$68.68	118.68	$8.75	.....	.....	$0.40	.40	127.83
February	50.00	157.77	207.77	3.70	132.84	.....	.....	132.84	344.31
March	50.00	213.79	263.79	4.20	310.32	527.59	15.75	853.66	1,121.65
April	50.00	.....	50.00	21.70	.....	9.52	44.55	54.07	125.77
May	50.00	.....	50.00	16.00	.....	4.50	.75	5.25	71.25
June	50.00	.....	50.00	.....	.....	.....	.....	.....	50.00
Total	600.00	440.24	1,040.24	54.35	463.71	617.40	61.45	1,142.56	2,237.15

C C 5.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The river and harbor act of August 5, 1886, contained an appropriation of $30,000 for the Allegheny River.

The greater portion of the appropriation was expended under the direction of I. V. Hoag, jr., in removing rocks from the channel of the river. For this purpose seven parties were organized, each party consisting of a foreman, from 20 to 30 men, and 5 or 6 teams, and these parties were distributed over the river from Olean to Pittsburgh.

The work of the season was the removal from the channel of the river of 17,558 cubic yards of rock and 503 snags.

Some material was accumulated for the construction of an inclined plane at the Corydon Dam, in order to facilitate the passage of boats

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and rafts, but the work of putting it in place was postponed until the season of 1887. Active operations were resumed in July, 1887, and are now progressing favorably.

ESTIMATE.

The estimate of last year, $40,000, not having been acted upon, is herewith renewed. A great deal of good has been accomplished by the work already done, but the channel is not yet wholly clear of rocks and other obstructions.

It is impossible to get reliable statistics of inland rivers, but the best information available puts the commerce of the Allegheny during 1886 at 40,000,000 feet of timber, 25,000,000 feet of dressed lumber, 1,200 new boats and barges, and a large but indeterminate miscellaneous trade in limestone, iron ore, coal, fire-clay, brick, salt, etc.

Money statement.

July 1, 1886, amount available	$634.29
Amount appropriated by act approved August 5, 1886	30,000.00
	30,634.29
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	23,784.06
July 1, 1887, amount available	6,850.23
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	40,000.00

C C 6.

LOCK AND DAM AT HERR'S ISLAND, ALLEGHENY RIVER.

This work has not yet been begun, as there is no authority to purchase the necessary land. At the close of the last fiscal year there were two legal obstacles to the building this lock and dam, the first being the lack of any cession of jurisdiction by the State of Pennsylvania over the land needed for the lock and the abutment, and the second being the lack of authority for the United States to purchase this land. The first of these obstacles was removed by an act approved May 18, 1887, granting the consent of the State of Pennsylvania to the acquisition by the United States of lands bordering on the navigable waters within the State, for the purpose of erecting thereon dams, abutments, locks, etc., and ceding jurisdiction over the same. A copy of this act is hereto annexed. The second obstacle remains in full force, and will prevent the actual beginning of construction until removed by act of Congress.

In my last annual report it was stated that the dimensions originally adopted in 1880 for this lock were now considered too small, and that a new estimate for a larger lock would be submitted. As originally designed it was of the same size (200 by 50 in the chamber) as the Gov-

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ernment locks on the Upper Monongahela. Further study has shown that a lock located like this, in the crowded harbor of Pittsburgh, ought to be large enough to pass, in one lockage, a tow-boat and two barges, as it is expected that it will be chiefly used by towing steamers with barges. For such use the lock should have a clear width of 53 feet, and the available length should be 285 feet, which is equivalent to 321 feet between hollow quoins. The capacity of the lock now proposed is therefore about 70 per cent. greater than that of the one originally designed.

ESTIMATE.

Recent examinations by boring show that there is no rock within reach, and both lock and dam will have to be built on piles. This fact, together with the increase in size of the lock, makes it necessary to increase the estimated cost of a lock and dam at this locality to $400,000, exclusive of the cost of the land. It is impossible to tell what will have to be paid for the latter until the exact site has been selected, and negotiations have been begun with the owners; but as the land on each side lies in the heart of a great city, it is thought that at least $20,000 ought to be set aside for this purpose. For obvious reasons it has been thought best to defer the selection of the exact site of the dam until the United States is ready to make the purchase.

Should the revised estimate herein submitted be thought too great for the results to be obtained, the matter can now be dropped without loss to the United States, as no expenditures have been made, except a trifle for office work.

In order that work on the lock may be carried on without interruption after it had been begun, an estimate of $100,000, in addition to the sum now in hand, is submitted for the next fiscal year.

For commercial statistics see the report on the Allegheny River.

Money statement.

Amount appropriated by act approved August 5, 1886	$37,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	160.00
July 1, 1887, amount available	37,340.00
Amount (estimated) required for completion of existing project	382,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

AN ACT to grant the consent to the State of Pennsylvania to the acquisition by the United States of certain lands bordering on the navigable waters within the State, for the purpose of erecting thereon dams, abutments, locks, lock-houses, offices, and necessary structures for the construction and maintenance of slackwater navigation on said rivers and ceding jurisdiction over the same, and for imposing fines and penalties for willful injuries to the grounds, buildings, and appurtenances acquired under the provisions of this act.

SECTION 1. *Be it enacted by the Senate and House of Representatives of the Commonwealth of Pennsylvania in general assembly met, and it is hereby enacted by the authority of the same,* That whenever the United States shall make an appropriation, and shall be about to begin the improvement of any of the navigable waters within the State of

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Pennsylvania by means of locks and permanent and moveable dams, or dams with adjustable chutes, the consent of the State of Pennsylvania, through the governor thereof, is hereby given, to the acquisition by the United States, by the purchase, or by condemnation in the manner hereinafter provided, of any lands, buildings, or other property necessary for the purpose of erecting thereon dams, abutments, locks, lock-houses, chutes, and other necessary structures for the construction and maintenance of slackwater navigation on said rivers, and the United States shall have, hold, use, and occupy the said land or lands, buildings, or other property, when purchased or acquired as provided by this act, and shall exercise jurisdiction and control over the same concurrently with the State of Pennsylvania.

SEC. 2. If the United States shall determine to take lands, buildings, or other property necessary for the purposes mentioned in the first section of this act, and can not agree with the owner or owners of such lands, buildings, or other property for the compensation to be made for such taking, the court of common pleas having jurisdiction in the county where such lands, buildings, or other property is situated shall, upon application by either the United States or the owner or owners, or any one in behalf of either, appoint three disinterested freeholders, who, having duly qualified before said court, and having given such public notice, and such notice to owners of the premises to be viewed and appraised, of the time and place of meeting as the said court may direct, shall ascertain and determine the amount of compensation to be paid to said owner or owners, and shall make reports to said court of their award on or before the first day of the term next after their appointment: *Provided*, That the said United States shall not be authorized to take possession of, or use, or occupy the lands, buildings, or other property taken under the provisions of this section until the amount of said award shall be paid to the owner or owners thereof: *Provided further*, That the said court may set aside the report of said viewers upon being satisfied that the amount of said award is excessive or insufficient: *And provided further*, That upon the application of any party aggrieved, made within thirty days after the filing of the report of the viewers, for an issue to try the facts in controversy between the respective parties and to determine the amount of compensation due for property condemned and taken, or for property injured or destroyed by the construction or enlargement of the works and improvements contemplated by this act, it shall be the duty of said court to award said issue; and any appeal taken pursuant to this act shall be signed by the party or parties taking the same, or by his or their agent or attorney, and shall be accompanied by an affidavit of the party appellant, or by his or their agent or attorney, that the same is not taken for the purpose of delay but because the affiant firmly believes that injustice has been done.

SEC. 3. That if any person or persons shall willfully or maliciously injure any of the lands, buildings, or other property acquired or held under the provisions of this act, such person or persons shall be liable to a fine of not exceeding one hundred dollars and to an imprisonment not exceeding six months, or both, or either, at the discretion of the court, said offense to be prosecuted and punished in any court of competent jurisdiction.

W. T. DAVIES,
President of the Senate.
HENRY K. BOYER,
Speaker of the House of Representatives.

Approved the eighteenth day of May, eighteen hundred and eighty-seven.
JAMES A. BEAVER.

C C 7.

ICE-HARBOR AT MOUTH OF MUSKINGUM RIVER, OHIO.

This work was begun in 1880, and at the present time is little more than one-half completed. The approved project is the construction of a large lock through the first or lower dam of the Muskingum River slackwater system, by means of which boats navigating the Ohio River can have access to the Muskingum Pool at times when there may be danger from ice-floods in the Ohio. The new lock is also designed for the use of all boats passing to and from the Muskingum River, as the old lock is in bad condition, and may at any time become impassable.

As the work now stands, the new lock-walls have been built to full height, or nearly so, from the upper end to 30 feet below the center of

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lock-chamber. This takes the walls past the line of the dam, but there yet remains some 220 feet of the lower end of the lock upon which no work of construction has been done.

The work thus far built is in excellent condition, except the part built in 1881, in which Buffalo cement was used. The samples of cement furnished by the Buffalo Cement Company were excellent, and the first few lots received from them came up to the sample, but the quality steadily deteriorated, until the cement was finally rejected.

The shortness of the working season, however, and the hurry in which work had to be done caused some lots to be accepted that would not have been taken under other circumstances. It was believed, however, that the cement would ultimately harden, and that the surplus of strength in the walls would justify the use of weak cement in an emergency. Such would probably have been the case had not a new and irremediable defect soon manifested itself—the cement kept steadily *swelling*. At first very minute cracks appeared in some of the joints, but these were supposed to be mere surface cracks due to expansion and contraction. The joints were opened out and repaired with wampum (American Portland) cement, and it was supposed that the matter was ended. The next season it was observed that the joints had opened again, and that some of the lower courses of stone were bulging. During the season of 1883 no work was done on the ice-harbor lock, on account of the failure of the river and harbor bill, and work was not resumed until 1884. By this time all the joints of the land wall, as far as built, had opened, and the removal and reconstruction of the wall was unavoidable. As there were no indications of failure below the level of the upper miter-sill, only the portion of wall above this level was taken down and rebuilt. Unfortunately the remedy was not sufficiently radical; leaks have since developed in the lower courses, which were allowed to remain, and the junction of the new wall with the old one is now marked by a wide vertical crack. If the cement would ever stop expanding the damages could be repaired and the work could be put in good condition, but thus far the action continues. The two piers above the lock, for the protection of the gates when open, are in a state of ruin from internal swelling. They will be rebuilt as soon as an opportunity can be found and funds can be spared. Notwithstanding these defects the lock can be made a strong and serviceable one, but I am afraid that it will always show disfiguring leaks, that ought never to be seen in well-built masonry.

The appropriation of $37,000 under act approved August 5, 1886, was not sufficient to put in the lower-end foundation and complete the work to low-water level, nor was the appropriation made in time to take advantage of the low-water season. No river work was therefore attempted last fall, but a force averaging 20 stone-cutters and 11 laborers was employed in the stone-yard from September 3 to December 3, cutting stone for the lock-walls. The amount cut during the three months was 5,221 square feet of face work and 353 blocks of special stone and coping. A small party was also employed three weeks in repairing the main dam alongside of the ice-harbor coffer, to prevent threatened serious damage to the latter. The cost of these repairs was $1,278.70.

No additional funds were available in the spring of 1887, but rather than delay the work any longer it was considered best to build a substantial coffer-dam and go on with the remaining foundation work during the low-water season, until the appropriation was exhausted. A project to this end was accordingly submitted and approved, and work

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was resumed in the early part of June, 1887. At the end of the fiscal year informal contracts had been entered into for furnishing the material needed for coffer-dam, the decayed plant had been partly overhauled and repaired, and a tramway has been built for handling material, a small amount of which had at that time been received.

After the winter ice had run out a few repairs were made to the old coffer-dam, and it is yet serviceable for present needs. The work remains under the local charge of Mr. William Weston, assistant engineer.

ESTIMATE.

The irregular prosecution of this work has materially added to its total cost, and at the end of the present season it will not be beyond risk of damage from floods and ice, as it is impossible, with the money now available, to bring the lock-walls up to low-water level. No exact estimate of the cost of completing the work can be made, while these risks and the uncertainties of adequate appropriations hang over it, but, as the best that can be done, I renew my estimate made last year, with the addition of $2,366.63 for the additional cost of another year's delay; the total estimate for the next fiscal year is therefore placed at $60,000, all of which ought to be appropriated at once, so as to finish the work and get it out of the way. With this sum it is thought that the lock can be put in working order in one season; any less appropriation will add to the total cost of the work.

The Muskingum Ice-Harbor will be used by boats navigating both the Ohio and Muskingum rivers. For statistics on commerce, attention is accordingly directed to my reports on the improvements of these rivers.

Money statement.

July 1, 1886, amount available		$11.67
Amount appropriated by act approved August 5, 1886		37,500.00
		37,511.67
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$9,594.75	
July 1, 1887, outstanding liabilities	65.19	
		9,659.94
July 1, 1887, amount available		27,851.73
Amount (estimated) required for completion of existing project		60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

C C 8.

OPERATING AND CARE OF THE LOCKS AND DAMS ON THE MUSKINGUM RIVER, OHIO.

Although the river and harbor act of August 5, 1886, authorized the United States to take possession of the Muskingum River as tendered by the State of Ohio, the act contained a clause which caused a great deal of delay, and required the passage of an additional act by the legislature of Ohio. The clause in question reads as follows:

The provisions of this act, so far as they relate to the Muskingum River, shall not take effect, nor shall the money hereby appropriated be available, until the State of Ohio, acting by its duly authorized agent, turns over to the United States all property ceded by the act of the general assembly aforesaid, and all personal property belong-

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ing to the improvement aforesaid, and used in its care and improvement, and any balance of money appropriated by said State for the improvement of said river, and which is not expended on the fifteenth day of July, eighteen hundred and eighty-six.

The river and harbor act did not pass until three weeks after the 15th of July, and the order to take possession of the Muskingum River was not issued until six weeks later, being special orders No. 227, headquarters of the Army, Adjutant-General's Office, September 30, 1886. As soon as this order was received, negotiations were opened by Lieutenant Beach (in temporary charge of this office) with the Board of Public Works of the State of Ohio, and that body was notified to prepare the necessary deeds, maps, and invoices of personal property. Meanwhile it was learned that the Board of Public Works had been compelled to expend, in current expenses, the greater portion of the money on hand on July 15, and were thus unable to make a literal compliance with the act of Congress. By letter of October 9, Lieutenant Beach laid these facts before the Chief of Engineers, with a request for instructions; and the latter officer forwarded the papers through the War Department to the honorable Comptroller of the Treasury for decision.

Under date of October 29, the Comptroller decided that duly authenticated vouchers might be accepted for payments made between July 15, and August 5, but that the State must pay over in cash the amount standing to the credit of the Muskingum River on the 15th of July, less the above-mentioned vouchers.

As the funds in the hands of the Board of Public Works were insufficient to meet the required payment, no further steps could be taken, and meanwhile efforts were made to obtain Congressional relief from the dead-lock. At the instance of the Hon. C. H. Grosvenor, an item was introduced into the river and harbor bill of 1887, relieving the State of Ohio from the obligation to pay over any money, and it was supposed that all the obstacles would thus be removed. Unfortunately this bill failed to pass, so that all hopes of relief from that quarter had to be abandoned. Parties interested in effecting the transfer immediately made application to the legislature of Ohio to appropriate the sum required by the Comptroller's decision. This application was successful, as appears from the accompanying letter from the governor of Ohio:

STATE OF OHIO, EXECUTIVE DEPARTMENT,
OFFICE OF THE GOVERNOR,
Columbus, April 7, 1887.

DEAR SIR: In accordance with the following provisions of the general appropriation act, passed by the general assembly of the State of Ohio on the 21st day of March, A. D. 1887, in the words and figures following, to wit:

"To be paid to the United States Government, for the purpose of consummating the transfer of the Muskingum River improvement and properties, the sum of $9,000, or as much thereof as may be necessary to complete said transfer: *Provided*, That the amount necessary shall be drawn by the governor of the State and be paid to the proper officers of the United States upon the full and final acceptance of said improvements and properties by the United States." I herewith hand you an order on the auditor of state of the State of Ohio for the sum of $7,233.20, and vouchers consisting of receipted pay-rolls and schedules of other expenditures, to the amount of $2,941.62, for disbursements by the State of Ohio made on and for the repair and benefit of the Muskingum River improvement, contracted prior to the 5th day of August, 1886, the sum being in full settlement and satisfaction of the balance of $10,174.82 of money appropriated by the State of Ohio for the improvement of said river unexpended on the 15th day of July, 1886, referred to in the act of Congress passed August 5, 1886, I hereby certifying that said sum of $10,174.82 was the full amount of said appropriation unexpended on the said 15th day of July, 1886.

I am, very respectfully, yours, etc.,

J. B. FORAKER,
Governor of Ohio.

Lieut. Col. WM. E. MERRILL,
Engineer Corps, U. S. A.

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Accordingly, on the 7th of April, I took possession of the Muskingum River, on the part of the United States, and received from Governor Foraker the sum of $7,233.20 in cash and $2,941.62 in duly authenticated vouchers, making a total of $10,174.82, and also an invoice of the personal property belonging to the Muskingum River. From Columbus I went to Zanesville and made a rapid inspection of the river, retaining all the old employés until their successors could be appointed. Lieut. Lansing H. Beach, Corps of Engineers, was assigned to the charge of the Muskingum as resident engineer, and Lieut. C. E. Gillette, Corps of Engineers, was afterwards assigned as his assistant.

After the river came into the possession of the United States, and an opportunity was afforded for a careful examination, it was discovered that its general condition was much worse than when it was examined in 1885. The work of deterioration had progressed rapidly, and as hardly anything had been done to check it, its effects were visible on all sides. Two of the dams (No. 2, at Devol's, and No. 5, at Luke Chute) were broken, and through navigation from Zanesville to Marietta had been stopped. All of the dams were in need of repair, and the same may be said of the locks and lock-gates. The dams are in worse condition than the locks, and it is possible that every dam on the river must be wholly or partly rebuilt before constant navigation can be assured.

The cause of this lamentable state of affairs is not far to seek. The Muskingum River improvement is a great engineering work, and to keep it up it should have constantly been under the charge of a skillful engineer. As a matter of fact, however, it has never (as far as any knowledge goes) been under charge of any one who had any professional knowledge, and the funds appropriated for its maintenance have been wastefully expended through sheer ignorance. If a dam gave way through defect of design, there was no one in charge who could detect the cause of the failure and could remove it in the reconstruction, and thus bad designs were perpetuated as long as funds held out. As matters now stand, there is not a dam on the Muskingum River that conforms in its design to the results of experience; and hence there is not one that I consider safe. The down-stream slopes are all too steep, and all of these slopes must ultimately be rebuilt. However, if once reconstructed in accordance with modern types, there is no reason why these dams should not last indefinitely, with occasional repair to the upper and exposed surface. I think it necessary to make this statement, lest it should be supposed to be impracticable to build a durable dam on the Muskingum River.

The locks all show signs of wear, especially in the chambers where the water-surface varies between the levels of the two pools, but they can readily be put in good working order by wooden linings backed with cement concrete. The only difficulty will be with those locks that have defective foundations for the walls and miter-sills; thus far, however, no case has been discovered that cannot be handled satisfactorily.

During the period of less than three months of the last fiscal year that the United States has had charge, much time was necessarily consumed in organization and in getting together an efficient force of lock-keepers and of foremen of repairs. There was also great difficulty in getting reliable information on which to act, as there were no maps of the river or of any lock or dam on it, no drawings of machinery of any kind, and no reliable maps of the real estate. For much of the property there are no deeds at all, and at least one of the tracts specifically deeded to the United States did not belong to the State of Ohio.

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While accumulating facts and organizing a permanent force, the work of repair was not neglected. The breaks in Dams 2 and 5 were rapidly repaired by brush and stone coffer-dams, and navigation was resumed within less than two months after the Government took charge. Unfortunately this condition did not last long, as a rise in June broke Dams Nos. 1 and 5 (the latter in a new place), and greatly endangered Dams Nos. 4 and 8. Work on these broken and injured dams was in active progress at the close of the fiscal year.

For further details reference is made to the accompanying report of Lieut. Lansing H. Beach, the resident engineer.

The allotment for operating and care of these locks and dams during the fiscal year ending June 30, 1888, is $190,000.

The estimated amount required for the fiscal year 1888–'89 is as follows:

Office and general administration	$7,200	Repairs to lock and dam No. 8	$10,700
Lock force	6,720	Repairs to lock and dam No. 10	3,500
Steamboat expenses	4,500	General repairs to gates and apparatus	2,300
Repairs to lock and dam No. 1	10,000	Dredge-boat expenses	9,000
Repairs to lock and dam No. 3	1,000	Contingencies, about 25 per cent.	18,580
Repairs to lock and dam No. 4	5,300		
Repairs to lock and dam No. 6	15,000		
Repairs to lock and dam No. 7	1,200		95,000

The above estimate is the best that can be made now, but it is not possible to put these old works in such a condition that they will not need heavy repairs for several years. From the present outlook I should say that the annual cost of maintaining the 10 dams and 11 locks on the Muskingum River can ultimately be brought down to $36,000 a year, as stated in my original report, but for several years to come the cost will probably be double this sum.

Money statement.

Amount appropriated by act approved August 5, 1886		$20,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,450.09	
July 1, 1887, outstanding liabilities	7,652.99	
		15,103.08
July 1, 1887, amount available		4,896.92

DETAILED STATEMENT OF EXPENSES INCURRED FOR OPERATING AND MAINTAINING THE LOCKS AND DAMS ON THE MUSKINGUM RIVER FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

	April, 1887.	May, 1887.	June, 1887.	Total, 1887.
General administration:				
Salaries	$240.17	$514.42	$1,017.00	$1,771.59
Plant	47.80	56.01	358.76	462.57
Contingencies	246.49	284.14	211.64	742.37
Total	534.46	854.67	1,587.40	2,976.53
Steamer General W. S. Jones:				
Salaries	115.30	298.25	296.50	710.05
Equipment	14.80	12.42	.....	27.22
Supplies	54.73	23.30	18.21	96.24
Repairs	34.84	17.04	5.80	57.68
Total	219.67	351.01	320.51	891.19

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DETAILED STATEMENT OF EXPENSES INCURRED FOR OPERATING AND MAINTAINING THE LOCKS AND DAMS ON THE MUSKINGUM RIVER, ETC.—continued.

	April, 1887.	May, 1887.	June, 1887.	Total, 1887.
Repair of lock and dam No. 1—Marietta & Harmar:				
Labor	.....	.....	$2,642.75	$2,642.75
Material	$13.60	$23.95	612.91	650.46
Boat-hire	.....	.....	19.50	19.50
Total	13.60	23.95	3,275.16	3,312.71
Repair of lock and dam No. 2—Devols:				
Labor	210.57	1,487.92	115.92	1,814.41
Material	143.55	2,314.27	943.77	3,401.59
Boat-hire	5.00	9.00	20.00	34.00
Total	359.12	3,811.19	1,079.69	5,250.00
Repair of lock and dam No. 3—Lowell:				
Labor	1.05	36.73	81.05	118.83
Material	1.60	6.71	.....	8.31
Total	2.65	43.44	81.05	127.14
Repair of lock and dam No. 4—Beverly & Waterford:				
Labor	.....	2.00	.....	2.00
Material	.....	6.20	.....	6.20
Total	.....	8.20	.....	8.20
Repair of lock and dam No. 5—Luke Chute:				
Labor	173.97	679.81	655.78	1,509.56
Material	39.45	82.52	610.61	732.58
Total	213.42	702.33	1,266.39	2,242.14
Repair of lock and dam No. 6—Windsor and Stockport:				
Labor	6.60	.....	.....	6.60
Material	.....	6.20	1.21	7.41
Total	6.60	6.20	1.21	14.01
Repair of lock and dam No. 7—McConnelsville and Malta:				
Labor	.....	.....	10.12	10.12
Material	.....	6.20.	2.34	8.54
Total	.....	6.20	12.46	18.66
Repair of lock and dam No. 8—Eagleport and Rokeby:				
Labor	.....	1.50	.....	1.50
Material	.....	10.07	.....	10.07
Total	.....	11.57	.....	11.57
Repair of lock and dam No. 9—Taylorsville and Duncan's Falls:				
Labor	.....	2.50	.....	2.50
Material	.....	6.20.	.....	6.20
Total	.....	8.70	.....	8.70
Repair of lock and dam No. 10—Zanesville:				
Labor	.....	3.77	29.44	33.21
Material	18.25	177.48	13.29	209.02
Total	18.25	181.25	42.73	242.23

Summary:

General administration	$2,976.53
Steamer General W. S. Jones	891.19
Lock and dam No. 1	3,312.71
Lock and dam No. 2	5,250.00
Lock and dam No. 3	127.14
Lock and dam No. 4	8.20
Lock and dam No. 5	2,242.14
Lock and dam No. 6	14.01
Lock and dam No. 7	18.66
Lock and dam No. 8	11.57
Lock and dam No. 9	8.70
Lock and dam No. 10	242.23
Total expenses incurred	15,103.08

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REPORT OF FIRST LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

SIR: In accordance with the provisions of the river and harbor act of August 5, 1886, the United States took possession of the locks and dams on the Muskingum River on April 7, 1887, the delay being due to causes fully set forth in your report.

On the 13th of April I was assigned by your order to the local charge of this improvement, and on the 3d of May First Lieut. C. E. Gillette, Corps of Engineers, reported at Zanesville, Ohio, as my assistant.

When the United States took possession of the river it was found that the works could hardly be in worse condition than they were. Dams Nos. 2 and 5 were both broken, the break at the former place completely interrupting navigation, and that at the latter locality rendering it very difficult and threatening to cut it off every day. Forces were immediately set to work to close these gaps, and though operations were conducted at an unfavorable stage of water, being several times interrupted by rises in the river, the break at No. 2 was closed on May 26 by a brush and stone dam 256 feet long and 25 feet high, and navigation restored; the break at No. 5 was repaired by a similar dam 70 feet long. The canal at No. 10 (Zanesville) was in great danger of breaking through into a culvert carrying a small stream under the canal, and prompt measures had to be adopted to save this work, which has now been rendered secure.

A heavy rise in the river in the fore part of June carried away about 100 feet of Dam No. 1 and 160 feet more of Dam No. 5, and placed Dams Nos. 4 and 8 in extremely dangerous condition, all navigation being stopped through the pools above the first-named dams. Work was begun immediately to repair the damage at these points, and the gap in No. 1 was closed on June 30. The gap at No. 5 has not been closed so rapidly, owing to the difficulty of procuring materials, no boats being able to reach the dam from either direction, and action was somewhat delayed by taking advantage of the opportunity to repair a serious leak in the miter-sill and through the wall at this lock before backing up the water again.

In addition to these defects there is not a dam upon the river, except, perhaps, No. 9, that does not need extensive repairs. The lock-walls at Locks Nos. 1, 6, 7, 8, and 9 are in great danger of falling. The gates at Nos. 4, 7, 8, and 10 demand renewing without delay, as they do not seem strong enough to stand the high water of another winter; and the canals at Nos. 3, 4, and 9 are almost impassable on account of the way in which the sediment has been deposited in them, and the canal at No. 10 can not be traversed except by small boats. And this general dilapidation of the larger works is reflected throughout in the demoralized condition of the smaller parts, such as the anchorages of the gates, the maneuvering apparatus, etc.

Every effort has been made to remedy this state of affairs, but the task has been of such magnitude that but little impression has been made in the short time that the improvement has been in the hands of the United States.

The State of Ohio did not have a map in its possession of any of the works, or of their vicinity, nor was any information concerning them received from the board of public works. A surveying party was put in the field as soon as possible, and is now engaged in gathering materials for a map of each locality; and with all attainable information at its disposal concerning the lands belonging to the improvement, collected piece-meal from various sources, it is hoped that the various tracts of land to which the United States is entitled by the transfer will be all identified and their boundaries defined.

The leases for water-power at various points had been allowed to drift into the utmost confusion, and much difficulty has been experienced in ascertaining the present status of each, but the following table is believed to be correct. There are no leases at Dams Nos. 5, 8, and 9.

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Leases of water-power on the Muskingum River improvement.

[Rent payable May and November.]

Locality.	No. of dam.	Lessees.	No. of cubic feet of water per minute.	Rent per annum.	Date of lease.	Lease expires.
Marietta	1	Phœnix Mill Company.*	3,000	$350	May 1, 1873	May 1, 1903
Do	1	Dircks & Bahlman	1,000	150	Feb. 15, 1879	Nov. 1, 1908
Devols	2	Gates & Payne†	1,200	175	Mar. 23, 1881	Mar. 23, 1911
Lowell	3	Rechsteiner Brothers‡	750	200	Nov. 1, 1873	Nov. 1, 1903
Do	3	F. Wilking & Co	2,000	250	....do	May 1, 1903
Beverly	4	H. C. Baldwin	1,200	100	May 11, 1875	May 1, 1905
Do	4	Mary L. Baldwin	1,200	100	Mar. 28, 1884	May 1, 1914
Do	4	I. D. Spooner	600	75	Nov. 1, 1884	Nov. 1, 1914
Do	4	D. T. Brown	1,750	63	July 13, 1886	July 13, 1916
Do	4	C. R. Stull§		225		
Stockport	6	Pierrot & Lane‖		250		
McConnelsville	7	Chase Andrews¶	1,000	100	Sept. 5, 1883	June 4, 1893
Zanesville	10	Carey Bros. & Silvey	500	100	May 1, 1862	May 1, 1892
Do	10	Drone & Co**		500	Dec. 7, 1871	Sept. 1, 1901
Do	10	Edward Johnson	6,100	400	Mar. 31, 1872	May 1, 1900
Do	10	Joseph Shaw	750	150	Sept. 6, 1881	Aug. 1, 1911
Do	10	Beaumont & Blankenbukle.	500	250	Oct. 6, 1885	May 1, 1907
Do	10	Herdman, Harris & Co	2,200	400	Apr. 13, 1886	May 1, 1891

* Ralston, Hall & Co. original lessees. No transfer.
† John Short original lessee. No record of transfer.
‡ Roach & Cassell original lessees. No record of transfer.
§ Lease expired, but allowed to continue by State. No copy in office.
‖ No lease in possession of office.
¶ Humphreys & McGrath original lessees. No record of transfer.
** Sufficient to propel five runs of 4½-foot millstones at rate to flour 150 bushels of wheat in twenty-four hours.

Land leases on the Muskingum River improvement.

Locality.	No. of dam.	Lessees.	Rate per annum.	Date of lease.	Lease expires.	Rent payable.
Marietta	1	Dircks & Bahlman	$10.00	Feb. 15, 1879	Nov. 1, 1908	Annually.
Lowell	3	E. W. Sprague	5.00	Dec. 2, 1879	Dec. 15, 1909	May 1 and Nov. 1.
Zanesville	10	Carey Bros. & Silvey	20.00	Dec. 10, 1873	Nov. 1, 1903	Do.
Do	10	A. P. Stultz*	50.00	May 29, 1877	May 29, 1907	May 1 and Nov. 1 in advance.
Do	10	William Miner	20.00	July 30, 1877	July 30, 1887	Half yearly in advance.
Do	10	Edward Martin†	20.00	Aug. 3, 1880	(§)	Aug. 3 in advance.
Symmes Creek	11	Sarah V. Plummer‡	1.00	Apr. 2, 1883	Apr. 2, 1889	Not specified.

* No payment was ever made on this lease.
† Tract 20 feet by 60 feet.
‡ Tract of 1.09 acres.
§ Privilege of renewal yearly.

Respectfully submitted,

LANSING H. BEACH,
First Lieut. of Engineers.

To Lieut. Col. W. E. MERRILL,
Corps of Engineers.

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C C 9.

HARBOR OF REFUGE NEAR CINCINNATI, OHIO.

The work in progress is the construction of a third dike in the Ohio River at Four-Mile Bar, 10 miles above Cincinnati, under contract with John J. Shipman, dated November 28, 1884.

This dike has been practically completed, although a small amount of paving still remains to be put in place under the contract. Its total length is 2,500 feet, and the following materials have been expended in its construction:

Brush	cords..	603.5
Riprap stone	cubic yards..	26,101
Timber	feet, B. M..	998,180
Bolts and spikes	pounds..	31,940
Excavation made	cubic yards..	417

In addition to the service rendered in checking and holding back large bodies of ice which might otherwise inflict serious injury on boats lying in the harbor of Cincinnati, the three dikes have greatly improved the low-water navigation at Four-Mile Bar, which was formerly one of the worst places on the river.

The allotment of $11,250, made by the river and harbor act of August 5, 1886, from the appropriation for improving the Ohio River was insufficient to complete the work, and a further allotment of $7,750 for this purpose was approved by the Chief of Engineers, in view of the necessity of completing the dike to aid in the general improvement of the river.

No more money need be appropriated for this work.

The benefit of this work accrues particularly to the river business centering at Cincinnati. Attention is therefore invited to the statistics of the river commerce of Cincinnati, as given in the report for improving Ohio River.

Money statement.

Amount appropriated by act approved August 5, 1886	$11,250.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	11,250.00

C C 10.

HARBOR OF REFUGE AT THE MOUTH OF THE GREAT KANAWHA RIVER

As stated in my last annual report, the ice-piers at this locality are completed. No work was done on them during the past fiscal year and no future work is contemplated.

Money statement.

July 1, 1886, amount available	$168.44
July 1, 1887, amount available	168.44

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C C 11.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

This river was under charge of Maj. J. C. Post, Corps of Engineers, until May 6, 1887, since which time it has been under the temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers.

The Big Sandy River, which is formed by the union of the Tug and Levisa forks at Louisa, flows north a distance of 26 miles, and empties into the Ohio at Catlettsburgh, Ky. The main river and the Tug (or eastern) Fork form the boundary line between West Virginia and Kentucky, and the upper part of the Tug, for a distance of about 18 miles forms the boundary between Virginia and West Virginia. The Tug Fork rises in the southwest corner of West Virginia, and flows north-northwest to its junction with the Levisa Fork, with a total length of about 140 miles. The Levisa (or Louisa) Fork rises in the southwestern part of Virginia, whence it enters Kentucky and flows in a northerly direction. Its total length is about 189 miles. The total length of the Big Sandy River is, therefore, 215 miles.

The present approved project for the improvement of this river contemplates the construction of a lock and dam at Louisa, below the junction of the two forks, and also the improvement of open-river navigation on these forks and on the main river. The object of building the dam is to form a pool for holding coal-boats and barges, with a view to the shipment of coal from the extensive deposits found in the valley. It is expected that other locks and dams will be built if this preliminary one should prove a success. For open-river navigation on the forks it is intended to secure a channel with a minimum depth of 1 foot and a minimum width of 50 feet during six months in the year. At present the forks are chiefly used for rafting, but there is occasional navigation as far as Piketon and Warfield by light-draught steamboats, and a large amount of material is poled up the river in push-boats. The country is mountainous, the roads are few in number and in poor condition, and the river is the chief reliance for obtaining such articles as cannot be grown or manufactured in the country.

The river and harbor act of August 5, 1886, appropriated $22,500 for the Big Sandy River, and $3,750 for each of the two forks. These appropriations came so late in the season that but little use could be made of them before work was stopped by high water and cold weather.

The appropriation for the main river was expended on the abutment and on the approaches to the lock. The foundation for the abutment was put in place and about half of the masonry was built. On the lock side the upper approach was made practicable by the removal of 6,000 cubic yards of rock, coal, and slate, which were used as filling behind the land-wall.

On the Levisa Fork work was done between Louisa and Pikeville, a distance of 87 miles, in removing obstructions and in building low wing-dams with rock taken from the river-bed.

On the Tug Fork the channel was cleared of obstructions over a length of 50 miles, but the chief improvements were the creation of a new and easy channel at Alley Island, 52 miles above Louisa, and the removal of a dangerous bar at Mose Maynard Island, 60 miles above Louisa. Both forks have now an unobstructed channel to the head of steamboat navigation, but annual work is necessary in order to take out new snags as they drift in from the tributaries.

For further details reference is made to the annexed report of Mr. B F. Thomas, resident engineer.

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ESTIMATE.

Major Post's estimate of $62,645.31, as the sum required to complete the existing project, is herein renewed.

Money statement.

July 1, 1886, amount available	$932.02	
Amount appropriated by act approved August 5, 1886	30,000.00	
		$30,932.02
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	19,465.08	
July 1, 1887, outstanding liabilities	578.93	
		20,044.01
July 1, 1887, amount available		10,888.01
Amount (estimated) required for completion of existing project		62,645.31
Amount that can be profitably expended in fiscal year ending June 30, 1889		62,645.31
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

SIR: I have the honor to report upon the works under my charge for the fiscal year ending June 30, 1887. The work consists of the construction of a lock and dam in Big Sandy River, just below Louisa, Ky., and the removal of obstructions to navigation in the Levisa and Tug forks.

The work done upon the Big Sandy during the year has been principally upon the abutment, though something has been done toward the excavation of the approaches to the lock and the building of the embankment behind it.

Owing to the late date at which money became available, work was not begun until early in October. Even then it was necessary to purchase piles and timber for the foundation before much could be accomplished, so that winter was upon us by the time we got started. However, over 10,000 yards of earth was excavated, 100 piles were driven, 20,000 feet of timber platform was put in, and 1,150 cubic yards of masonry was constructed, so that now the abutment masonry is more than half completed, and the entire foundation is ready. In addition to the abutment work, the excavation of the upper lock approach has been about completed. This consisted of some 6,000 cubic yards of solid rock, coal, and slate, and the material thus taken out has been used in the embankment behind land-wall of lock. A perforated tile drain has also been placed behind this wall to carry off the water coming in from the adjoining hill-side.

REMOVAL OF OBSTRUCTIONS TO NAVIGATION.

Parties were sent out upon the Levisa and Tug forks on October 12 to improve the navigation of these streams. The work consists of the removal of snags, fallen trees, stumps, etc., from the channel; leaning trees from the shores and bowlders from the bends; the cleaning of shoals; the construction of new chutes where needed, and the building of wing-dams and walls for concentrating the water during the dry season.

The improvement of Levisa Fork was made from Louisa to Pikeville, 87 miles, and many dangerous obstructions were removed, notably those near Louisa, where two freight-boats had been sunk, the snags at George's Creek, where both boats and rafts had been damaged during the spring, and the several snags and stumps at Gravis, Fannin's, Chestnut, Wild Goose, and Ward City. Stumps, trees, and snags were also taken out at Greasy, Buffalo, Paintsville, Hell Gate, Draw Bars, John's Creek, Prestonsburgh, Ball Alley, Beaver, Laynesville, and Gaines. These obstructions were removed by cutting and sawing, and blasting with dynamite into such pieces that they could be piled and burned, or allowed to float off.

Several important wing-dams were constructed of the bowlders removed from the shoals, many of which will be permanent improvements, although most of them are easily damaged by ice. Other wing-dams will have to be built, and other chutes constructed, when the water is low enough, notably at Buffalo, Preston Ripple, Sugar Loaf, and Gaine's Shoals.

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There remains on hand about $1,500 with which to prosecute this work, which will be expended during the low-water season now coming on; with this expenditure the river below Pikeville will need nothing more at present. The river above Pikeville has had but little done upon it for several years, and $2,500 could be very profitably expended between that place and the Virginia State line, in removing rocks, snags, and drift, so that timbermen could the more safely and rapidly get their rafts out in times of freshets, and also in extending the steamboat navigation 13 miles during a part of the year. This would be of great advantage to the people of all the upper part of the valley.

The Tug Fork improvements were similar to those of the Levisa Fork for the first 50 miles, but the principal work was done at Alley Island, 52 miles above Louisa; this has long been the most dangerous point in the navigable part of the river on account of the sharp bends around the island and the narrowness of the chute. The work done here was the construction of an entirely new and straight channel 1,300 feet long and 60 feet wide through the island, and the closing of the old channel by a dam 180 feet long, and a secondary channel by a dam 40 feet in length. The winter's freshets have widened and deepened this new chute, and it has proven entirely satisfactory to navigation. A similar obstruction existed at Mose Maynard Island, 60 miles above Louisa, where rafts have been torn up every year and a great deal of property destroyed and damaged. The bar here, 140 feet in length by 55 feet wide and 3 feet deep, was entirely removed, since which time timber has been run in safety, and no damage has been done.

This fork is now in good condition from Louisa for a distance of 60 miles. The tugboats left Louisa on the 5th of June, with a view of improving the navigation above the 60-mile point as far as possible with the available funds. This part of the river is greatly obstructed by mill-dams; an order has been issued by Major Post to have all these removed, or so modified that they will not interfere with the navigation, and this order will be carried out during the present month.

Twenty-five hundred dollars will be required to complete the improvement of this fork above Pond Creek, which is 58 miles above Louisa, the junction of the Tug Fork with the Big Sandy. Below that point no more work need be done until further obstructions show themselves in the channel. Below is a statement showing the principal work done on the two forks.

Summary of work done on Levisa and Tug Forks during year ending June 30, 1887.

Class of work.	Levisa Fork.			Tug Fork.		
	Number.	Length.	Circumference.	Number.	Length.	Circumference.
Snags	239	30	6.5	308	20	4
Fallen trees	196	75.5	8	369	45	7.5
Stumps	295	.....	.....	193	.....	.....
Solid rock .....cubic yards..	245	.....	.....	1,092	.....	.....
Loose rock .....do....	2,221	.....	.....	3,050	.....	.....

The close of the year shows the lock completed, except gates and wickets; the abutment over half finished, with stone and cement on hand to complete it; the upper approach to the lock excavated; the embankment behind the lock nearly done; and all the work in good condition to withstand the action of floods. Both forks of the river have an unobstructed channel to the head of steamboat navigation.

In conclusion I desire to express my appreciation of the faithful manner in which I have been assisted by those in charge of parties upon the work.

Respectfully submitted.

B. F. THOMAS,
Assistant Engineer.

To Lieut. Col. WM. E. MERRILL,
Corps of Engineers

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Commercial statistics, Big Sandy River, West Virginia and Kentucky, for fiscal year 1886–'87.

Articles.	Quantity.	Average price.	Total.
Apples, dried ..... pounds..	27,000	5 cents per pound	$1,350.00
Apples, green ..... barrels..	357	$1.50 per barrel	535.50
Beans ..... bushels..	840	$1.35 per bushel	1,134.00
Beeswax ..... pounds..	4,560	30 cents per pound	1,368.00
Butter ..... do....	16,860	25 cents per pound	4,215.00
Corn ..... bushels..	2,022	45 cents per bushel	909.90
Eggs (30 dozen per case) ..... cases..	5,170	$3.30 per case	17,061.00
Feathers ..... pounds..	94,950	42 cents per pound	39,879.00
Furs ..... bags..	200	$8 per bag	1,600.00
Ginseng ..... pounds..	16,020	$1.75 per pound	28,035.00
Hides ..... do....	9,680	10 cents per pound	968.00
Honey ..... do....	14,245	10 cents per pound	1,424.50
Leather ..... do....	35,588	30 cents per pound	10,676.40
Oats ..... bushels..	671	40½ cents per bushel	271.75
Peaches, dried ..... pounds..	63,500	7 cents per pound	4,473.00
Potatoes ..... bushels..	394	80 cents per bushel	315.20
Roots ..... pounds..	63,600	30 cents per pound	19,080.00
Rye ..... bushels..	528	92 cents per bushel	485.76
Sheep pelts ..... bales..	63	$2.75 per bale	173.25
Sorghum ..... barrels..	5,970	$8 per barrel	47,760.00
Tallow ..... pounds..	18,000	6½ cents per pound	1,170.00
Tobacco ..... hogsheads..	15	$100 per hogshead	1,500.00
Wheat ..... bushels..	24,150	80 cents per bushel	19,320.00
Wool ..... pounds..	518,720	30 cents per pound	155,616.00
Total	.....	.....	359,231.26

Articles.	Number.	Average price.	Value.
Live stock:			
Cattle	3,432	$28 per head	$96,096.00
Hogs	4,328	$7 per head	30,296.00
Horses	195	$80 per head	15,600.00
Mules	60	$100 per head	6,000.00
Poultry	60,689	$3 per dozen	15,172.25
Sheep	1,696	$2.50 per head	4,240.00
Total	.....	.....	167,404.25
Timber:			
Ash logs ..... cubic feet..	91,200	10 cents per cubic foot	9,120.00
Oak logs ..... do....	562,800	10 cents per cubic foot	56,280.00
Poplar logs ..... do....	8,275,120	10 cents per cubic foot	827,512.00
Walnut logs ..... do....	596,480	55 cents per cubic foot	328,064.00
Mixed logs ..... do....	163,480	8 cents per cubic foot	13,107.20
Total	.....	.....	1,234,083.20
Lumber:			
Poplar ..... feet, B. M..	100,000	$18 per thousand	1,800.00
cellaneous:			
Coal splint ..... tons..	150	$2.40 per ton	360.00
Locust for hubs ..... lineal feet..	1,000	28 cents per lineal foot	280.00
Railroad ties ..... number..	1,000	47 cents each	470.00
Staves ..... do....	4,500,000	$15 per thousand	67,500.00
Tan-bark ..... cords..	575	$14 per cord	8,050.00
Walnut knots ..... pounds..	650	40 cents per pound	260.00
Total	.....	.....	76,920.00

SUMMARY.

Produce	$359,321.26
Live stock	167,404.25
Timber	1,234,083.20
Lumber	1,800.00
Miscellaneous	76,920.00
Exports	1,839,528.71
Carried by push-boats	33,526.50
Imports	1,014,523.66
Passengers per boat	12,000.00
Total	2,899,578.87

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Commercial statistics of upper river commerce connecting with railroad at Richardson, Ky., for fiscal year 1886–'87.

Articles.	Quantities.	Average price per unit.	Value.
Beans.....bushels..	2,571	$1.26	$3,239.46
Bees-wax.....pounds..	1,509	.30	452.70
Cattle.....head..	13	28.00	364.00
Coal, cannel.....tons..	291	3.00	873.00
Corn.....bushels..	116	.56	64.96
Eggs.....cases..	1,060	3.30	3,498.00
Feathers.....pounds..	23,513	.42	9,875.46
Flaxseed.....do....	1,234	.01½	17.62
Furs.....bags..	24	8.30	199.20
Ginseng.....pounds..	5,266	1.75	9,215.50
Hides, dried.....do....	2,709	.09	243.00
Hides, green.....do....	6,450	.04½	290.25
Hogs.....head..	289	7.00	2,023.00
Honey.....pounds..	940	.10	94.00
Horses.....head..	8	80.00	640.00
Leather.....pounds..	1,793	.28	502.04
Potatoes.....bushels..	22½	.80	18.00
Poultry.....dozen..	463	2.50	1,157.50
Roots, assorted.....pounds..	7,950	.30	2,385.00
Sheep pelts.....bales..	6	2.75	16.50
Sorghum.....barrels..	1,770	8.00	14,160.00
Spokes.....number..	530,000	*12.00	6,360.00
Tallow.....pounds..	400	.06½	26.00
Wheat.....bushels..	702	.80	561.60
Wool.....pounds..	14,697	.30	4,409.10
Total.....	.....	.....	60,685.89
Imports, miscellaneous merchandise, 2,011 tons, at $100 per ton	.....	.....	201,100.00
Grand total.....	.....	.....	261,785.89

*Per 1,000.

C C 12.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

This river was under charge of Maj. J. C. Post, Corps of Engineers, until May 6, 1887, since which time it has been under the temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers.

The Guyandotte River rises in the southwestern part of West Virginia, flows in a northwesterly direction, and enters the Ohio 12 miles above the mouth of the Big Sandy, and 39 miles below the mouth of the Great Kanawha.

Since the last annual report the Rogers Mill-dam has been removed, and all the available funds have been expended. This mill-dam was the most serious obstruction on the river, and its removal has been a great benefit to the rafting and push-boat interest.

ESTIMATE.

There yet remain other similar obstructions that ought to be removed, and an estimate of $2,000 for future work is therefore submitted.

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Money statement.

July 1, 1886, amount available	$2,000.00
Amount reappropriated by act approved August 5, 1886	2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	50.00
July 1, 1887, outstanding liabilities	1,950.00
	2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

Commercial statistics for year ending December 31, 1886, Guyandotte River, West Virginia.

Articles.	Quantity.	Average price per unit.	Value.
Apples ..... barrels	2,534	$1.50	$3,801.00
Peaches, dried ..... pounds	44,000	.05	2,200.00
Beans ..... bushels	500	2.00	1,000.00
Butter and eggs			15,000.00
Corn ..... bushels	47,500	.40	19,000.00
Oats ..... do	5,500	.40	2,200.00
Wheat ..... do	16,950	.65	11,017.50
Potatoes ..... do	4,000	.50	2,000.00
Rye ..... do	2,000	.40	800.00
Feathers ..... pounds	12,000	.50	6,000.00
Wool ..... do	25,000	.40	10,000.00
Ginseng, dry ..... do	13,100	1.90	24,890.00
Tobacco ..... do	187,500	.08	15,000.00
Tan-bark ..... cords	600	16.00	9,600.00
Hoop-poles ..... number	833,100	*12.00	9,997.20
Staves ..... do	4,000,000	*25.00	100,000.00
Logs:			
Poplar ..... cubic feet	3,750,000	.12	450,000.00
Oak ..... feet, B. M.	10,000,000	*10.00	100,000.00
Walnut ..... cubic feet	150,000	.60	90,000.00
Lumber, sawed ..... feet	15,625,000	*16.00	250,000.00
Total exports			1,122,505.70
Total imports			350,000.00
Total imports and exports			1,472,505.70

*Per 1,000.

C C 13.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

This river was under the charge of Major J. C. Post, Corps of Engineers, until May 6, 1887, since which date it has been under the temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers.

The Little Kanawha drains the central portion of West Virginia, rising in Upshur County, and flowing thence in a course a little north of west until it empties into the Ohio River at Parkersburg; its total length is about 150 miles.

The present project for the improvement of the river, adopted in 1876 and modified in 1880, contemplates the construction of a lock and dam

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to extend slackwater navigation for a draught of 4 feet a distance of 12 miles, and the improvement of the natural channel of the upper river by the removal of obstructions for a distance of 80 miles; the object of the latter being to obtain a channel of a minimum width of 40 feet, containing at least 2 feet of water during four months of the year.

The work of building the lock under the appropriation of August 5, 1886 ($15,000), was begun on the 29th of September, and was continued until the 30th of November, at which date the upper end of the river wall from its head to the upper hollow-quoin had been completed to a height of 16 feet 4 inches, and the remainder of the river wall to a height of 11 feet 4 inches, out of a total height of 25 feet. No work had been done on the land wall except on its upper wing, which had been built to a height of 17 feet 10 inches, and the masonry had been stepped down as far as the upper face of the filling culvert. The upper head-wall had been finished, and the upper mitre-wall with its culverts was three-fourths done. Nothing had been done on the lower mitre-wall, or on the floor of the lock chamber.

It having been found necessary to have a larger quantity of stone for the work than had been purchased under the stone contract, advertisements were issued soliciting proposals for furnishing 1,090 cubic yards additional stone. The bids were opened on May 11, but as the prices named were considered too high, all proposals were rejected, and arrangements were made for quarrying the necessary stone by hired labor. At the close of the fiscal year the quarry had been opened, the necessary plant had been assembled, and 54 cubic yards of stone had been quarried.

The work of improving the open-river navigation above the lock and dam was begun in the latter part of October, and was closed on November 23 on account of high water. During this time the chute at Spicer's Mill was completely repaired, the dike at Dusk Camp was raised 2 feet and repaired, and the chute at Glenville was torn out and partly rebuilt. The completion of the repairs of this chute is now in progress.

For further details of the work done in 1886 reference is made to the annexed report of Mr. M. W. Venable, the resident engineer.

ESTIMATE.

Major Post's estimate of $51,800 as the amount required to complete the approved project is herewith renewed.

Money statement.

July 1, 1886, amount available		$971.04
Amount appropriated by act approved August 5, 1886		16,875.00
		17,846.04
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$9,646.93	
July 1, 1887, outstanding liabilities	414.18	
		10,061.11
July 1, 1887, amount available		7,784.93
Amount (estimated) required for completion of existing project		51,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		51,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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COMMERCIAL STATISTICS.

The following statement of the commerce of the Little Kanawha River for the year ending June 30, 1887, has been kindly furnished by Mr. L. B. Dellicker, superintendent of the Little Kanawha Navigation Company:

Commerce of Little Kanawha River for year ending June 30, 1887.

Articles.	Quantities.	Average price.	Value.
Exports.			
Coal ..... bushels..	49,200	$0.06	$2,952.00
Grain ..... do....	2,784	.60	1,670.40
Logs ..... cubic feet..	2,723,000	.15	408,450.00
Lumber ..... feet, B. M..	7,466,500	*30.00	223,995.00
Oil ..... barrels..	4,400	1.00	4,400.00
Railroad-ties ..... number..	205,885	† .30	61,765.50
Staves ..... do....	2,062,500	†18.00	371,250.00
Tan-bark ..... cords..	292	10.00	2,920.00
Wood ..... do....	522	2.00	1,044.00
Total			1,078,446.90
Imports.			
Merchandise ..... pounds..	2,131,660	Value unknown.	

*Per thousand feet. †Per thousand.

The passenger traffic during the year was equivalent to 24,652 passengers through one lock.

REPORT OF MR. M. W. VENABLE, ASSISTANT ENGINEER.

SIR: The work assigned me for the season of 1886 was the continuance of the work at Lock 5, near Burning Springs, W. Va. (building the river-wall and upper miter-wall of the lock), and the repairs of the dikes and chutes on the river above the mouth of the West Fork.

The season for work was far advanced before the money appropriated by Congress at its last session for the further prosecution of this work became available, hence active operations could not be begun earlier than September 24, but from that time until the close of the season the work was pushed with considerable vigor, with the following results:

WORK ON LOCK AND DAM NO. 5.

After setting machinery (derricks, tramways, pumps, and engines) excavation for foundation was begun at the lower end of the coffer-dam, and was extended up the river until the concrete and masonry laid during 1885 had been uncovered; it was also extended downward to an average depth of 3 feet 10 inches below the top of concrete of 1885, when a stratum of blue shale was reached, which was rising as it extended down-stream, and dipped rapidly transversely of the lock; so much so, that at the extreme lower end of wall the foundation had to be cut 15 to 18 inches into this material on the outside of the wall in order that the foundation might be level transversely and be entirely on this material. On this foundation was laid a course of concrete 3 feet 10 inches thick, composed of cement 1 part, sand 1 part, and broken stone 4 parts, thoroughly mixed with a little water, and dumped in and rammed. The cement, though slow setting, was sufficiently hard in three days to begin building on. Setting stone was begun on the 11th of October and continued with little or no interruption until November 27, when, the weather becoming frosty and bad, it was considered best to close building for the season. During the month of October a night force was worked to considerable advantage, backing up and filling with concrete and mortar the spaces left between the outer and inner faces of the wall, which had been laid during the day; this was discontinued, however, after November 1 as unprofitable, most of the work set then being special stone around culverts, etc.

The work was all built according to plans furnished, except a modification of the small shafts for wicket rods. The drawing accompanying this report shows the shape of the masonry at the close of the season.

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The following tabulated statement shows the amount and cost of different classes of work done, not including cost of material furnished except cement:

Excavation in foundation	cubic yards..	$417.68
Concrete in foundation	do....	144.48
Masonry built (1,504.2 cubic yards), cement, and labor		2,785.05
Stone cut, 326 cubic yards		1,861.50
Miscellaneous expenses		625.30
Supervision		757.00
		6,591.01

MATERIAL EXPENDED.

Coal	bushels..	3,800
Cement	barrels..	1,025
Cut stone and backing	cubic yards..	1,500
Broken stone	do....	250

WORK ON RIVER ABOVE WEST FORK.

Owing to the lateness of the season and the small amount appropriated little work could be undertaken toward repairing the dikes and chutes on the river above the mouth of West Fork, so it was considered best to apply it where most needed by navigation, and where it might save old work from complete destruction by water during the coming winter.

The points selected for work were the chute in Spicer's Mill Dam, the dike at Dusk Camp Shoal, and the chute in Holt's Mill Dam at Glenville. Work was undertaken at these points with the following result:

The chute in the dam at Spicer's Mill was found loosened from its foundations, the lower 8 feet of it torn off and gone, and the timbers to some extent rotted; it was all taken up from the dam down-stream, and the foundation timbers refastened to the rock by means of long drift-bolts driven into holes previously drilled into the rock and filled with seasoned wooden plugs, and on the sides these anchors extended up high enough to be fastened through the guard-walls by means of pins passing through loops in the anchors and then through the timbers. All the space underneath the floor was then filled with broken stone. On this foundation such of the old flooring as was sound was spiked on with 12-inch spikes and the rotten timbers throughout replaced by new timber, the guards were almost entirely renewed, the piers were refilled and resheeted with 2-inch oak, the cross-dike in the pond was refilled, and a washout in the ford below the dam (caused by the creek discharging into the river through a gap in the dike left for a roadway) was filled with broken stone and rendered safe. Cost of labor at this point was $273.34; materials used were 465 pounds spikes, 246 pounds iron, 20 pounds nails, 7,796 feet B. M. lumber, 4 pounds powder, and 25 feet fuse.

At Dusk Camp Shoal it was found that the creek which enters the river at the upper end of the dike passed over the upper cross-dike during sudden rises, and had cut away the county road and damaged to some extent the adjacent field, and passed into the river again at the gap in the dike about 300 feet below left for the roadway; to prevent this, and to confine the creek to its channel, the upper cross-dike was raised and extended, making a total length of 125 feet and a height of 6½ feet, built of heavy white-oak logs bolted down with 24-inch bolts, and the main dike was also raised 2 or more feet from its upper end down-stream for 150 feet. The whole was then filled with broken stone, and the main dike repaired at such points as required it, and the county road filled where washed into holes. Total cost of labor, $267.15. Materials expended: 1,536 linear feet timber, 300 pounds spikes, and 343 cubic yards broken stone.

The chute in the dam at Glenville was found badly out of repair, having floated up from its foundation so high as to allow drift to get under it, and when the waters went down it was left in very bad shape, all the lower end destroyed and gone. What remained of it was torn up and the bottom timbers refastened, there being very little space between the bottom of floor and the river-bed. To give the structure more weight such old flooring as was unsuitable to use again as such was fastened to the first foundation timbers, and then the space between this and the floor was carefully filled with stone. The foundation rock is poor, consisting of thin ledges with clay between, rendering anchoring by means of bolts unsatisfactory, so that we have to depend more on the specific gravity of the structure to keep it down than on the anchors. All old timber in bad condition was taken out and replaced by new, and all repairs nearly completed, when a rise in the river put a stop to the work, and the river continuing up the season's work closed, leaving 16 feet of the lower end un-

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sheeted. The lumber and spikes for this are on hand. The cost of labor on this work was $319.96.

Materials expended: 14,180 feet, B. M., lumber and 850 pounds spikes and iron. Lumber on hand, 5,760 feet, B. M. Spikes on hand, 250 pounds.

Respectfully submitted,

M. W. VENABLE,
Assistant Engineer.

To Maj. JAS. C. POST,
Corps of Engineers.

C C 14.

IMPROVEMENT OF BUCKHANNON RIVER, WEST VIRGINIA.

This river was under charge of Maj. J. C. Post, Corps of Engineers, until May 6, 1887, since which time it has been under the temporary charge of Lieut. Col. W. E. Merrill, Corps of Engineers.

The Buckhannon is one of the tributaries of the Tygarts Valley River, which, with the West Fork, forms the Monongahela; its total length from its headwaters to its junction with the Valley River is 57 miles. The portion under improvement is the 24½ miles between the Three Forks, 10 miles below the headwaters, and the town of Buckhannon, and the object of the improvement is to remove the obstruction to rafting, in order to bring into market the immense quantity of fine timber on the headwaters of this river.

Before any work of improvement was done, the annual output of logs was about 100,000 linear feet, and there was every prospect that large quantities of valuable timber would be destroyed while clearing lands for farming purposes from sheer inability to get it to market. The maximum output of the most favorable year was 115,000 linear feet, while the product of last year was 8,100,000 feet, or seventy times as great. The increase since the previous fiscal year has been four-fold.

Work under the appropriation of August 5, 1886, was begun on the 27th of September, and closed for the season at the end of November.

It was resumed in June and ended on the 30th of that month on account of the exhaustion of the appropriation. During the working season 204 rocks, aggregating 5,628 cubic yards, were removed from the bed of the river in the vicinity of Ten-Mile Creek, and a channel 30 feet wide, with a minimum depth of 2 feet during four months in the year, has been opened at this point.

ESTIMATE.

There is yet much that might be done to improve the rafting capacity of this river, and I therefore renew Major Post's estimate of $5,000 as the sum that could be advantageously expended during the next fiscal year.

Money statement.

July 1, 1886, amount available		$37.38
Amount appropriated by act approved August 5, 1886		1,500.00
		1,537.38
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,532.85	
July 1, 1887, outstanding liabilities	.85	
		1,533.70
July 1, 1887, amount available		3.68
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		5,000.00

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Commercial statistics for year ending December 31, 1886, Buckhannon River, West Virginia.

Articles.	Quantities.	Average price.	Value.
Poplar logs.....feet B. M..	2,500 000	$6 per thousand.....	$15,000
Oak logs.....do. ..	200,000	$8 per thousand.....	1,600
Locust posts.....number ..	1,500	10 cents each.....	150
Locust hub cuts.....do....	500	10 cents each.....	50
Coal.....bushels..	10,000	5 cents per bush.....	500
Total.....			17,300

C C 15.

PRELIMINARY EXAMINATION FOR ICE-HARBOR AT PADUCAH, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

GENERAL: I have the honor to submit the following report of a preliminary examination, "for an ice-harbor at Paducah, Kentucky," as ordered by the river and harbor act of August 5, 1886.

For the reasons stated by Lieut. Lansing H. Beach, Corps of Engineers, in his report hereto annexed, I have to state that the locality is not "worthy of improvement," in the sense that no work is required here at the expense of the United States.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

SIR: I have the honor to submit the following report on the preliminary examination for an ice-harbor at Paducah, Ky.

The object of the citizens of Paducah in asking that an ice-harbor be made at that place was, not that an appropriation should be made or works constructed for that purpose, but that the existing fine harbor of refuge should be recognized by the Government, and the Government craft on the Mississippi ordered to winter there. The Tennessee River forms the best possible harbor for boats on the Ohio or Upper and Middle Mississippi rivers, and as there is no instance on record of a vessel ever having been injured at that point by the ice, the citizens took steps, after the disaster to the Mississippi River Commission fleet in February, 1886, to have the advantages of that locality prominently presented, with the hopes of preventing the repetition of such an occurrence, and also of profiting incidentally from the presence of the vessels and their crews. No appropriation is asked, and none is needed, as the harbor is, as far as experience extends, already perfectly safe.

The locality is not "worthy of improvement."

Very respectfully,

LANSING H. BEACH,
First Lieut. of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

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C C 16.

PRELIMINARY EXAMINATION OF THE BAR AT THE MOUTH OF LIMESTONE CREEK, IN THE HARBOR OF MAYSVILLE, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

GENERAL: I have the honor to submit the following report upon the preliminary examination of "the bar at the mouth of Limestone Creek, in the harbor of Maysville," which was ordered by the river and harbor act of August 5, 1886.

For the reasons given by Lieut. Lansing H. Beach, Corps of Engineers, in his report hereto annexed, I have to state that the locality is not "worthy of improvement," in the sense that no special appropriation is needed for work at this point. The bar in question is in the Ohio River, and in case of its interference with navigation it can be removed by the Ohio River dredges as a part of their ordinary service, without the need of the special interposition of Congress.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

SIR: I have the honor to submit the following report on the preliminary examination at mouth of Limestone Creek, Maysville, Ky.

Limestone Creek is merely a drainage channel for the hillsides back of and in the immediate neighborhood of Maysville; its greatest length is about 4 miles, in which distance it falls nearly 400 feet. It has almost no water at all, except just after a rain or when the snow is melting, but, as might be expected from the conditions, the velocity of its current is very high when the quantity of water in the stream is at all considerable. The people of Maysville claim that the creek is carrying such an amount of sediment into the river as not only to threaten the destruction of the harbor, but also to seriously interfere with the general navigation of the river, and ask that the mouth of the creek be so fixed as to prevent further transfer of material, and that relief be afforded from the present unfavorable conditions in the channel and at the landing. An examination of the river failed to disclose any obstructions at either place of sufficient magnitude to require any attention or action at present. A cloudburst in rear of the city on July 31, 1882, caused a great flood in the creek, and an immense wash of material into the river; this created something of a bar, which had a tendency to throw the current across to the side of the convex bank and to form a deposit in front of the city, but from all that could be learned, the channel is gradually resuming its former position and depth, nor has the creek thrown out any appreciable quantity of sediment since. Should the bar ever become troublesome, a few days' work of the dredges would be sufficient to counteract the evil.

The locality is not worthy of improvement.

Very respectfully,

LANSING H. BEACH,
First Lieut. of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

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C C 17.

PRELIMINARY EXAMINATION OF BIG HOCKHOCKING RIVER, OHIO, FROM ITS MOUTH TO COOLVILLE.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

GENERAL: I have the honor to submit the following report on the preliminary examination of the "Big Hockhocking River from its mouth to Coolville," ordered by the river and harbor act of August 5, 1886.

The locality is "worthy of improvement," but no survey is required, as the preliminary examination developed all the necessary facts.

The examination was made by Lieut. Lansing H. Beach, Corps of Engineers, whose report is herewith submitted.

Respectfully, your obedient servant,

WM. E. MERRILL,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF LIEUTENANT LANSING H. BEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 11, 1887.

SIR: I have the honor to submit the following report on the preliminary examination of the Big Hockhocking River from its mouth to Coolville:

The Big Hockhocking, or Hocking, as it is more generally called, rises about 35 miles south of east of Columbus, Ohio, and flowing, first southerly, then southeasterly, empties into the Ohio about 12 miles below Parkersburgh, W. Va., after a course of about 89 miles.

The object desired is to have the overhanging trees cut down and obstructions in the channel removed, so that the lighter-draught boats navigating the Ohio can, on the medium and higher stages of that river, turn in and run up to Coolville, about 5 miles fron the mouth of the Hocking. Coolville is a village of about 500 inhabitants and the center of a rich farming country, the larger part of whose produce it is claimed would seek outlet by river were it possible for boats to reach that point. It is not desired to render the stream navigable above Coolville, at which place there is a dam across the river, furnishing water-power to a large flouring mill. It is not expected that any coal will be brought down from the upper Hocking, but that Pittsburgh coal will be brought by river at a much lower rate than is now afforded by the railroads. At present boats do occasionally run up to Coolville on the higher stages in the Ohio, but this is not frequently attempted on account of the danger from overhanging trees and a few large rocks in the channel; but were these removed it is probable that the local packets would run to Coolville regularly, and other boats quite frequently.

The object desired can be effected at a very small cost, and the advantages which would result to commerce will apparently more than justify the expenditure necessary. The locality is worthy of improvement.

An estimate of the amount required to carry out the desired improvement can be made without resorting to a survey of the river.

Very respectfully,

LANSING H. BEACH,
First Lieutenant of Engineers.

Lieut. Col. W. E. MERRILL,
Corps of Engineers, U. S. A.

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APPENDIX D D.

IMPROVEMENT OF THE FALLS OF THE OHIO AND OPERATING AND CARE OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, AND OF KENTUCKY AND TRADEWATER RIVERS, KENTUCKY—OPERATING AND CARE OF LOCKS AND DAMS ON KENTUCKY RIVER.

REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio, Louisville, Kentucky.
2. Indiana Chute, Falls of the Ohio River.
3. Operating and care of the Louisville and Portland Canal.
4. Wabash River, Indiana and Illinois.
5. White River, Indiana.
6. Kentucky River, Kentucky.
7. Operating and keeping in repair locks and dams on the Kentucky River, Kentucky.
8. Improvement of Tradewater River, Kentucky.

EXAMINATIONS.

9. Whether or not the Government dry-dock at the Louisville and Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making the same.
10. Pond River, Kentucky.
11. Louisa [Levisa] Fork of Sandy River, Virginia.
12. Licking River, Kentucky, from Farmers to West Liberty.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., August 15, 1887.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge for the fiscal year ending June 30, 1887.

I was assisted by First Lieut. Eugene J. Spencer, from November, 1886, to the end of the fiscal year.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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D D 1.

IMPROVEMENT OF THE FALLS OF THE OHIO RIVER AT LOUISVILLE, KENTUCKY.

By the river and harbor act approved August 5, 1886, this work, which at first consisted of the enlargement of the upper portion of the Louisville and Portland Canal, was made to include the enlargement of the basin of the canal just above the locks.

ENLARGEMENT OF UPPER PORTION OF LOUISVILLE AND PORTLAND CANAL.

This work, which was begun in July, 1885, has been carried on during the fiscal year, when the stage of river would permit.

The progress has not been as rapid as it should have been. One of the contracts for excavation, embracing the lower section of the work, was completed in December, 1886. On the other two contracts it was found necessary to extend the time to December, 1887.

In the river and harbor act of August 5, 1886, an appropriation of $150,000 was made for this work, of which $100,000 was available for this portion, and $50,000 for the enlargement of the canal basin.

It was determined to apply the $100,000 to the construction of a portion of the new wall, which is to separate the enlarged canal from the river. After due advertisement the work was awarded to and contract made with the Salem Stone and Lime Company, of Louisville, Ky. The stone to be used is the oolitic limestone from the quarries of Salem, Ind., and the cement the best quality of Louisville manufacture. The contract covers a length of wall of about 1,750 feet, reaching from the railroad bridge to the eastern extremity of the wall, about opposite Tenth street, with two openings of 125 feet each, where it is proposed to construct sluices. The company soon got to work preparing stone, and began building June 1, 1887. At the end of the month they had laid 630.82 yards. The rock bottom at the site of the wall was found in places to be shattered below grade by the blasting in excavating, and the work of removing this has been done by a small force of hired labor. The report of Mr. G. W. Shaw, assistant engineer, is appended.

ENLARGING BASIN OF CANAL.

This work consists in widening that part of the canal which extends from the new locks to the basin above, a distance of about 800 feet. The present width is 90 feet, and the enlarged width will be 215 feet. The object of this enlargement is to permit boats coming out of the lock to pass boats that are lying in the canal at the head of the locks waiting to come in. In the river and harbor act approved August 5, 1886, $50,000 was appropriated for beginning this work. After due advertisement a contract was made with Gleason & Gosnell for making the necessary excavations. They commenced work in the latter part of January, and at the end of the fiscal year had excavated 66,246 cubic yards of earth and 341 cubic yards of rock.

The excavated material is being placed on the lock grounds to raise them above the extreme height of river floods. The total amount of excavation required is estimated at 124,000 yards of earth and 13,000 yards of rock. The new retaining-wall will require about 5,200 cubic yards of masonry. A change of position of the buildings used as shops

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and store-houses became necessary and some of these have been removed. It is proposed to apply any funds that may become available during the next fiscal year to a continuation and, if possible, completion of the excavation and construction of the new wall.

The report of Mr. J. P. Claybrook, assistant superintendent, is appended.

The commercial statistics will be found in that part of the report relating to the Louisville and Portland Canal.

Money statement.

July 1, 1886, amount available		$217,449.82
Amount appropriated by act approved August 5, 1886		150,000.00
		367,449.82
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	65,435.60	
July 1, 1887, outstanding liabilities	21,092.11	
		86,527.71
July 1, 1887, amount available		280,922.11
Amount (estimated) required for completion of existing project, head of canal		935,363.00
Amount (estimated) required for enlarging basin		70,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		370,000.00

Abstract of proposals for excavation of about 137,000 *cubic yards of earth and rock for enlargement of canal basin, received in response to attached advertisement dated Louisville, Ky., November* 5, 1886, *and opened December* 8, 1886, *by Lieut. E. J. Spencer, Corps of Engineers.*

No.	Names of bidders.	Earth excavation, price per cubic yard.	Rock excavation, price per cubic yard.	Total cost.	Date when work will be commenced.	Date when work will be completed.	Number of men to be employed on the work.
1	Donald McDonald	$0.35	$0.98	$56,140	5 days after contract is signed.	Oct. 1, 1887	As many as there may be room for.
2	Francis H. Smith	.45	1.70	77,900	Mar. 1, 1887	Jan. 1, 1888	Fifty.
3	C. I. McDonald	.42	1.10	66,380	As soon as weather will permit.	Dec. 15, 1887	25 minimum; 150 maximum.
4	Roderick Mackenzie	.32	1.40	57,880	Mar. 1, 1887	Oct. 1, 1888	Seventy-five.
5	Stephen M. Williams, Roy McDonald.	.36	.95	56,990	Jan. 1, '87, if ordered.	Dec. 1, 1887	100 average per day.
6	Patrick E. Roach, G. W. Lewis.	.44	1.29	71,320	Within 30 days' notice from U. S. Engineer Office.	Within 365 working days from commencement.	100 to 150, or an equivalent in excavating machinery.
7	Marshall Morris, T. H. McMichael.	.27	.90	45,180	Jan. 1, 1887	Jan. 1, 1888	One hundred.
8	J. J. Shipman & Co., A. J. Shipman.	.34	.82	52,820	Mar. 1, 1887	Dec. 31, 1888	100 or more.
9	John D. Lyle, Frederick Dahn.	.24	.80	40,160	Mar. 1, 1887	Dec. 1, 1887	One hundred.
10	Gleason & Gosnell	.17½	1.05	35,350	Jan. 15, 1887	Jan. 1, 1888	One hundred.

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Abstract of proposals for construction of 9,000 *cubic yards (more or less) of canal wall, received in response to attached advertisement dated Louisville, Ky., November* 5, 1886, *and opened December* 8, 1886, *by Lieut. E. J. Spencer, Corps of Engineers.*

No.	Names of bidders.	Price per cubic yard.	Total cost.	When work will be commenced.	When work will be completed.
1	Horace Scott	$11.25	$101,250	May 1, 1887	Dec. 15, 1887
	Henry F. Holmes	16.00	144,000		
2	John J. Shipman & Co	13.00	117,000	....do	Sept. 30, 1888
3	David Y. Johnson	10.70	96,300	April 15, 1887	Nov. 1, 1888
4	William F. Shanks	11.50	103,500	January 1, 1887	Nov. 25, 1888
5	Salem Stone and Lime Company.	10.43	93,870	March 1, 1887	Dec. 31, 1887
6	Francis H. Smith	11.44	102,960	....do	Dec. 1, 1887
7	Marshall Morris, T. H. McMichael.	13.00	117,000	January 1, 1887	Jan. 1, 1888
8	Patrick E. Roach, George W. Lewis.	13.48	121,320	Within thirty days' notice from U. S. Engineer Office.	Dec. 31, 1887
9	C. I. McDonald	14.34	129,060	April 15, 1887	Dec. 15, 1887
10	Scott Webber	18.27	164,430	As early as river will allow.	Dec. 1, 1888
11	Donald McDonald	11.92	107,280	Five days after contract is signed.	Dec. 15, 1887
12	Thomas Mumford	10.89	98,010	April 1, 1887	Dec. 1, 1887
13	I. V. Hoag, jr*	13.24	119,160	June, 1887	Dec., 1887

* Received and opened 2.15 p. m. December 8, 1886, by Maj. A. Stickney.

Abstract of contracts.

Name: Gleason & Gosnell. *Date:* January 13, 1887. *Purpose and consideration:* That the said Gleason & Gosnell shall perform the following work, viz: 124,000 cubic yards, more or less, of earth excavation, and 13,000 cubic yards, more or less, of solid rock excavation, for enlarging the basin of the Louisville and Portland Canal at the head of the locks; that the said Maj. Amos Stickney shall pay the said Gleason & Gosnell for the said excavation as follows: For earth excavation, 17½ cents per cubic yard; for solid rock excavation, $1.05 per cubic yard. Measurements to be made in place.

Name: The Salem Stone and Lime Company. *Date:* January 15, 1887. *Purpose and consideration:* That the said Salem Stone and Lime Company shall construct 9,000 cubic yards, more or less, of the new wall for the Louisville and Portland Canal; that the said Maj. Amos Stickney shall pay the said Salem Stone and Lime Company for said construction the sum of $10.43 per cubic yard, on monthly estimates, as provided for in the specifications.

REPORT OF MR. GRANVILLE W. SHAW, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 25, 1887.

MAJOR: I have the honor to submit the following report of operations on improving the Falls of the Ohio River at Louisville, Ky., for the fiscal year ending June 30, 1887.

The present project is the enlargement of the upper end of the Louisville and Portland Canal, and is being executed in accordance with plans recommended by Lieut. Col. William E. Merrill, Corps of Engineers, in his annual report for 1883, with some modifications suggested in his report for 1885.

The work has been carried on under four contracts, viz: with George W. Lewis, for excavating earth and solid rock on the lower section; with John Molloy, for excavating earth and solid rock on the middle section; with Gleason & Gosnell, for excavating solid rock on the upper section; and with the Salem Stone and Lime Company, for constructing the new canal wall. The contracts with Lewis and Molloy were executed on July 1, 1885, the work to be completed by December 31, 1886.

The lower section, Lewis, contractor, was finished to grade November 24, 1886. By a supplemental contract the time for completing the middle section, Molloy contractor, was extended to December 31, 1887. The original contract with Gleason & Gosnell for the upper section was executed August 4, 1885, with the provision that the work was to be completed by December 31, 1886. By a supplemental contract the time was extended to December 31, 1887. The contract with the Salem Stone

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and Lime Company for constructing the new canal wall was executed January 15 1887.

On the middle section the earth, loose and solid rock, and dry wall have nearly all been removed and about 18 per cent. of the solid rock excavation made to grade. The contractor continued work until November 24, 1886, on which date he was run out by high water. He began pumping and removing mud on the 11th of May, 1887, and on the 20th of the same month commenced using his steam-drills. On June 6 rock excavation was resumed, and the work has proceeded without interruption since. On the upper section work was continued during the fall of 1886, until November 19, at which time the work was flooded by a rise in the river, and nothing further was done until July 27, 1887, when the contractors, having pumped out their quarry, began using their steam-drills.

On the 8th of December, 1886, bids were opened for the construction of about 9,000 cubic yards of masonry in the new canal wall, and the contract was awarded to the Salem Stone and Lime Company, of Louisville, Ky. About the middle of April the contractors began pumping out their foundation pit, but before any work could be done a sudden rise in the river flooded the work, and it was not until the 26th of May that the water and heavy deposit of mud were removed. In clearing the foundation of the wall it was discovered that the ledge below the grade was badly shaken in some places, from the effect of blasting in excavating the solid rock above, and a small force of laborers was employed to remove this material in advance of the contractor's work. The first stone was laid in the wall on June 1, and the work has proceeded since without interruption by water. The approximate quantities to be removed on the upper, middle, and lower sections were estimated as follows:

Materials.	Upper section, Gleason & Gosnell.	Middle section, John Molloy.	Lower section, George W. Lewis.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	94,461	103,356
Solid-rock excavation	110,000	46,449	37,402
Loose-rock excavation	.....	1,500	500
Dry wall removed	.....	4,152	5,413

The following quantities had been removed from the upper and middle and lower sections on June 30, 1887:

Materials.	Upper section, Gleason & Gosnell.	Middle section, John Molloy.	Lower section, George W. Lewis.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	63,900.06	86,649.13
Solid-rock excavation	15,446.84	9,303.43	32,897.16
Loose-rock excavation	.....	4,633.10	8,813.21
Dry wall removed	.....	11,089.39	9,922.50

The following shows the amount of materials excavated and masonry laid during the fiscal year ending June 30, 1887:

Materials.	Upper section, Gleason & Gosnell.	Middle section, John Molloy.	Lower section, George W. Lewis.	Canal wall, Salem Stone and Lime Company.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Earth excavation	.....	21,261.96	7,881.43	.....
Solid-rock excavation	13,738.44	9,308.43	17,624.56	.....
Loose-rock excavation	.....	3,513.40	5,449.21	.....
Dry wall removed	.....	3,727.99	2,057.50	.....
Masonry	.....	.....	.....	630.85

Very respectfully, your obedient servant,

GRANVILLE W. SHAW,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

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REPORT OF MR. J. P. CLAYBROOK, ASSISTANT SUPERINTENDENT LOUISVILLE AND PORTLAND CANAL.

UNITED STATES LOUISVILLE AND PORTLAND CANAL OFFICE,
Louisville, Ky., July 27, 1887.

SIR: I have the honor to report to you on the "enlargement of the basin of the Louisville and Portland Canal, at the head of the locks," that Messrs Gleason & Gosnell commenced work under their contract for excavation dated January 13, 1887, on January 26, 1887, and have since continuously prosecuted their work as follows:

Earth excavation	cubic yards..	66,246
Rock excavation	do....	341

The contractors, Messrs. Gleason & Gosnell, have on the work three hoisters, thirteen cars, and one steam-drill.

On the 27th of January, 1887, a contract was made with William Newhouse, of New Albany, Ind., to move the engineer's tool-house, the carpenter's shop, and the framing-shed. The engineer's tool-house has been moved to a position near the superintendent's office, out of the way of the excavation, where it will remain till its new site shall have been prepared.

The carpenter's shop has been moved from its original position and placed on its new site. The framing-shed has been moved to one side, out of the way, and waits but the grading of the new site selected for it. The old shop's cistern has been torn down, the brick hauled off and cleaned. Some of them have been used in the construction of the new cistern; some are still on hand, and are to be used in foundation pillars of the shops. The old planing-mill has been torn down. All serviceable material has been preserved for future use. Of the new material needed for reconstruction a part has been received and a part is still lacking. A new cistern has been built. Upon an examination of it the plastering was found to be defective in spots. It was gone over, and all bad places replastered. It is thought now the cistern will be found entirely water-tight. No pipes for conducting water to the new cistern have as yet been laid, as it is desired to have the new-made ground settled as much as possible.

Very respectfully, your obedient servant,

J. P. CLAYBROOK,
Assistant Superintendent.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

D D 2.

IMPROVEMENT OF THE INDIANA CHUTE, FALLS OF THE OHIO RIVER.

Work on this chute was resumed September 15, and continued till November 18, when the rise in the river compelled a stoppage of work. A considerable portion of the right-hand ledge was removed, adding about 40 feet for a distance of about 300 feet to the available width of the channel. The cross dam at the head of the falls was found to need considerable repair, much of the top planking, and in some places the timber work and stone filling, having been carried away.

Repairs were made so as to place the dam in very fair condition. The movable dam across the middle chute and the portion of dam extending into the Indiana Chute were raised during the extreme low water and found to be in fair order, needing small repairs, which were made.

In order to obtain exact information concerning the surface slopes of the water in Indiana Chute at various stages of the river, eight gauges were placed along the river bank extending from a point about 2,300 feet above the dam, to a point opposite Rock Island. These gauges have been read at various stages of rising and falling river, and the records present some valuable and curious information concerning the changing of the slopes.

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We fortunately succeeded in placing the upper gauge at about the crest of the falls slope. A project for improvement of this chute was submitted to the Chief of Engineers, November 1, 1886.

The project had in view the making of a channel by suitable dikes at moderate cost, navigable for coal boats at all stages when they could reach Louisville. With such a channel the canal would be relieved to such an extent that its capacity would be sufficient for the rapid passage of all commerce needing to use it for many years to come. The estimated cost of this projected work was $200,000.

As this work is provided with funds from the appropriation for improving the Ohio River, the estimate will be found in the report of Lieut. Col. W. E. Merrill, Corps of Engineers, the officer in charge of that work.

The application of any funds that might become available during the next fiscal year would be the continuation of rock excavation and repairs of dam, and construction of dike.

The commercial statistics will be found in that part of the report relating to the Louisville and Portland Canal.

Money statement.

July 1, 1886, amount available	$4,262.15
Allotment from amount appropriated by act approved August 5, 1886	20,000.00
	24,262.15
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	4,488.19
July 1, 1887, amount available	19,773.96
Amount (estimated) required for completion of existing project	120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

D D 3.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL.

The canal has been kept in good condition and was open for passage of commerce two hundred and ninety-two days, and closed seventy-three days. The closing was caused by high water for the unusual period of fifty-nine days, when boats passed over the falls; by ice, eleven days, and by dredging at lock gates, three days.

Considerable repairing has been done to lock gates, the dwelling-house for assistant superintendent, office, bridge floors, and floating plant.

The long duration of high water left a large amount of deposit in the canal and locks, which, as yet, has only been partially removed. A new iron-hull dredge was finished and set to work during the year, and one of the old ones transferred to the Kentucky River work.

A new towboat, tender for the dredge, was also finished and placed at work, and it is proposed to dispose of the old one, which is almost unserviceable, at public sale.

The locks and part of canal adjacent have been supplied with electric lights, the plant being placed by the Fort Wayne Jenney Electric Light

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Company. One of the engine-houses was enlarged to accommodate the dynamo, a twelve-light machine, and its engine.

The work of enlarging the basin of the canal just above the locks is well under way, with funds provided in the appropriation for improving the Falls of the Ohio, and the report of the work is under that head.

This work has necessitated the changing of position of a number of the buildings used as shops and store-houses.

A large amount of old unserviceable iron and other material which had been collecting for a number of years was sold at public sale. The high canal banks above the lock-walls have continued, as in past years, to slide, and it is proposed during the coming year to pave the lower part of these slopes and to flatten the upper part.

It is also proposed to build two new mud-scows of larger dimensions than those now in use, in order to utilize the greater capacity of the new dredge. The guard-gates, at both old and new locks, are showing such signs of decay that it is necessary to provide for the building of new ones, and the chains for moving the gates will have to be renewed. The coal used for all canal purposes during the year was furnished under contract by Mr. Austin H. Dugan, and, after due advertisement, contract was again awarded to Mr. Dugan for furnishing coal for the coming year. At the beginning of the year the hull of the new tow-boat was being constructed, under contract, by M. A. Sweeny & Bro., of Jeffersonville, Ind.

On August 9, 1887, proposals were opened for the machinery of this boat, and contract awarded to the same firm. The boat was completed and put to work, as heretofore mentioned.

The usual tables accompany this report, and show a large commerce passing this point.

The report of Mr. Thomas H. Taylor, superintendent of the canal, is appended. The estimate for cost of operating and care of the canal for the fiscal year ending June 30, 1888, is as follows:

Regular pay-rolls	$35,080
Extra labor	5,000
Miscellaneous, fuel, oil, etc	5,000
General repairs	7,380
New guard-gates, new locks	8,000
New guard-gates, old locks	2,345
Paving slopes above lock-walls	6,000
Two new mud-scows	4,000
Contingencies	5,000
	77,805

This estimate does not include the cost of a new dredge, which must soon be provided.

Financial statement for the fiscal year ending June 30, 1887, operating and care of Louisville and Portland Canal, Kentucky.

Receipts.		Expenditures.	
Items.	Amount.	Items.	Amount.
Dry-dock	$1,033.95	Office and general administration	$12,620.18
Auction sale	1,095.20	Canal and locks	24,823.89
Dredging	41.25	Dredging	12,862.44
Rent	97.50	Completing new dredge and towboat	21,973.80
		Electric light	2,917.02
Total	2,267.90	Total	75,197.33

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Statement showing cost of passing boats and freight through the Louiscille and Portland Canal, Kentucky, for the fiscal year ending June 30, 1887, including all expenditures except for new dredging plant and electric light.

Per lockage	$13.46
Per boat	10.55
Per ton	.04

Cost, exclusive of new plant and dredging and electric light.

Per lockage	$10.02
Per boat	7.85
Per ton	.03

Detailed statement of expenditures, operating, and care of Louisville and Portland Canal Kentucky, for the fiscal year ending June 30, 1887.

Date.	Office and general administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1886.								
July	$775.00	$25.67	$375.73	$1,176.40	$1,180	$89.00	$921.75	$2,190.75
August	950.00	27.57	123.52	1,101.00	1,185	101.05	883.07	2,169.12
September	811.50	54.86	135.61	1,001.97	1,185	35.86	1,419.10	2,639.96
October	775.00	.....	170.13	945.12	1,185	82.98	1,884.67	3,152.65
November	950.00	16.64	80.71	1,047.35	1,185	102.18	1,460.39	2,747.57
December	670.00	52.99	149.48	872.47	1,215	103.13	541.20	1,859.33
1887.								
January	670.00	5.85	158.73	834.58	1,185	113.09	202.35	1,500.44
February	800.00	35.69	47.78	883.47	1,200	3.65	209.10	1,412.75
March	685.00	32.50	135.78	853.28	1,200	225.49	348.60	1,774.09
April	930.00	28.23	91.90	1,050.13	1,210	73.06	590.21	1,873.27
May	835.00	56.63	1,066.35	1,957.98	1,210	127.13	381.56	1,718.69
June	850.00	9.88	36.45	896.33	1,240	137.52	407.75	1,785.27
Total	9,701.50	346.51	2,572.17	12,620.18	14,380	1,194.14	9,249.75	24,823.89

Date.	Dredging.				Electric light.	New plant.	Aggregate.
	Labor.	Supplies.	Repairs.	Total.			
1886.							
July	$830	$235.11	$77.33	$1,142.44	.....	$9,084.98	$13,594.57
August	830	148.05	52.74	1,030.79	$69.12	1,470.26	5,840.38
September	830	193.30	169.44	1,192.74	.....	158.33	4,993.00
October	830	240.17	62.47	1,132.64	.....	.....	5,230.42
November	830	193.12	26.81	1,049.93	6.75	.....	4,851.60
December	830	116.31	116.12	1,062.43	209.72	5,536.06	9,540.01
1887.							
January	830	40.40	16.25	886.65	.90	373.00	3,597.57
February	830	19.50	8.50	858.00	1.80	150.00	3,306.02
March	830	325.13	22.74	1,177.87	75.90	5,199.17	9,080.31
April	830	180.51	7.22	1,017.73	2,510.73	.....	6,451.86
May	862	244.54	30.53	1,137.07	40.45	.....	4,854.19
June	851	272.74	50.41	1,174.15	1.65	.....	3,857.40
Total	10,013	2,208.88	640.56	12,862.44	2,917.02	21,973.80	75,197.33

Money statement.

July 1, 1886, amount available		$27,741.30
Allotment from amount appropriated by act approved July 5, 1884		82,320.00
		110,061.30
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$71,629.61	
July 1, 1887, outstanding liabilities	3,567.72	
		75,197.33
July 1, 1887, amount available		34,863.97

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Abstract of proposals for furnishing coal, received in response to the attached advertisement, dated June 14, 1886, and opened July 15, 1886, by Major Amos Stickney, Corps of Engineers.

Coal.	1. Austin H. Dugan.	2. Jos. Walton & Co.	Quantity required.
	Cents.	Cents.	Bushels.
Best Pittsburgh coal.....per bushel..	8½	9	8,000
Second pool Pittsburgh coal.....do....	8½	9	900
Ohio River or Kanawha coal.....do....	6½	(*)	22,800

*No bid.

Abstract of proposals for furnishing engines and machinery and setting up same on the Louisville and Portland Canal towboat, in response to the attached advertisement dated July 19, 1886, and opened August 9, 1886, by Major Amos Stickney, Corps of Engineers.

No.	Name of bidder.	Price per whole work complete.
1	Hamlin F. Frisbé.....	$7,660.80
2	M. A. Sweeney & Brother.....	*4,760.00
3	Ainslie, Cochran & Co.....	5,155.00

*Recommended for acceptance.

Abstract of proposals for furnishing forage, received in response to the attached advertisement dated April 28, 1887, and opened May 28, 1887, in the absence of Major Amos Stickney, Corps of Engineers, by B. H. Cooper, clerk.

Articles.	1. B. B. Connor.	2. Geo. Becker.	3. Casler, Troxell & Co.	Quantity (more or less) required.
Best timothy hay.....per cwt..	$0.65	$0.64	$0.69	10,000 pounds.
Best black oats.....per bushel..	.35	.34	.34	300 bushels.
Best wheat straw.....per cwt..	.35	.35	.30	500 pounds.
Best middling bran.....do....	.75	.75	.84	600 pounds.
Total cost.....	176.25	172.25	177.54	

Abstract of proposals for furnishing coal, received in response to the attached advertisement of April 28, 1887, and opened May 28, 1887, in the absence of Major Amos Stickney, Corps of Engineers, by B. H. Cooper, clerk.

Coal.	1. Byrne & Speed.	2. Austin H. Dugan.*	3. Joseph Walton & Co.†	Quantity (more or less) required.
Best Pittsburgh coal.....per bushel..	$0.11½	$0.11	$0.10	1,000 bushels.
Second pool Pittsburgh coal.....do....	.11½	.11	.10	900 bushels.
Ohio River or Kanawha coal.....do....	.08½	.08	.....	24,800 bushels.
Anthracite egg coal.....per ton..	7.50	7.25	6.75	8 tons.
Anthracite nut coal.....do....	7.50	7.50	7.00	8 tons.
Total cost.....	3,454.50	3,301.00	.....	

*Recommended. † Received after the hour of opening, and no bid on third item.

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Abstract of proposals for furnishing 20,000 pounds (more or less) pure Northern Lake ice, received in response to the attached advertisement, dated April 28, 1887, and opened May 23, 1887, in the absence of Major Amos Stickney, Corps of Engineers, by B. H. Cooper, clerk.

Where to be delivered.	1. Northern Lake Ice Company.	2. Wm. Lock and Joseph Jacquemine.	Quantity required.
United States Engineer's office, 507 West Chestnut street.....per cwt..	$0.50	$0.50	10 pounds daily.*
Branch office Louisville and Portland Canal, foot Third street.....per cwt..	.50	.50	10 pounds daily.
Locks of Louisville and Portland Canal .....do....	.50	.50	75 pounds daily.
Total cost.....	100.00	100.00	

* Except Sunday

Abstracts of contracts.

Name: Austin H. Dugan. *Date:* July 23, 1886. *Purpose and consideration:* That the said Austin H. Dugan shall furnish coal for use at offices in Louisville, Ky., and at the Louisville and Portland Canal, for the fiscal year ending June 30, 1887, as follows: 23,300 bushels, more or less, of Ohio River or Kanawha coal; 9,800 bushels, more or less, of the best Pittsburgh coal; 900 bushels, more or less, of second pool Pittsburgh coal; that the said Maj. Amos Stickney shall pay for the said coal, when delivered as required, at the following rates, viz: For Ohio River or Kanawha coal, 6¼ cents per bushel; for the best Pittsburgh and second pool Pittsburgh coal, 8½ cents per bushel.

Name: M. A. Sweeney & Bro. *Date:* August 17, 1886. *Purpose and consideration:* That the said M. A. Sweeney & Bro. shall furnish the labor and materials, and shall build and set up in complete working order on board the Louisville and Portland Canal towboat, a pair of engines and machinery as required by said specifications; that the said Maj. Amos Stickney shall pay the sum of $4,700 for the said engines and machinery, as soon as practicable after acceptance of the work by the United States.

Name: Austin H. Dugan. *Date:* June 13, 1887. *Purpose and consideration:* That the said Austin H. Dugan shall furnish coal for use on the Louisville and Portland Canal and offices at Louisville, Ky., for the fiscal year ending June 30, 1888, as follows: 25,300 bushels, more or less, of Ohio River or Kanawha coal; 11,800 bushels, more or less, of the best Pittsburgh coal; 900 bushels, more or less, of second pool Pittsburgh coal; 8 tons, more or less, of anthracite egg coal; 8 tons, more or less, of anthracite nut coal. That the said Maj. Amos Stickney shall pay for the said coal, when delivered as required, at the following rates, viz: For the Ohio River or Kanawha coal, 8 cents per bushel; for the best Pittsburgh and second pool Pittsburgh coal, 11 cents per bushel; for anthracite egg coal, $7.25 per ton; for anthracite nut coal, $7.50 per ton.

REPORT OF MR. THOMAS H. TAYLOR, SUPERINTENDENT OF THE LOUISVILLE AND PORTLAND CANAL.

UNITED STATES LOUISVILLE AND PORTLAND CANAL OFFICE,
Louisville, Ky., July 1, 1887.

SIR: I respectfully submit the annual report of operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1887.

The canal was open and in operation 292 days; it was closed 73 days; caused by high water 59 days, by ice 11 days, and 3 days by dredging at lower lock-gates. The old locks were in use from October 11 to November 13, 1886, on account of low water just below mouth of new canal, which forced the boats to use old canal. During the year 4,768 vessels, representing an under-tonnage of 1,157,250, were passed through the canal. The following items of commerce are particularly mentioned as passing through the canal during the year: 25,850,801 bushels of coal, 66,479 tons of iron ore, 75,795 barrels of salt, 7,463,890 feet of lumber, 53,004 barrels of oil, 28,762 tons steel rails, 34,796 bales cotton, 7,443 barrels of whisky, and 11,880 hogsheads of tobacco.

Attached find table. A new mudscow was completed in July, 1886, and a portable office for the Falls of Ohio River was built. The Thenard shutters in dam were fully

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repaired. A house to hold the hose-reel was built in the rear of office at the locks. The new dredge *Louisville* arrived from Cincinnati on the 24th of August, 1885, was received and put to work. It being much larger than the old dredges, does a proportionate larger amount of work while at work, but unfortunately has had to lay up frequently for repairs, owing as much to lack of skill in handling as any thing else. On March 19, 1887, the new tender *Major McKenzie* was received to take the place of the *Walker Morris*, now too old to render much service. The upper part of guard-gates of old canal, eastside, which had rotted down, was rebuilt. The crib abutment at mouth of old canal, being completely worn out, has been replaced by a new crib. The lintels of eight drums in well-holes, new locks which had rotted, have been replaced. A road on canal bank on north side, from old locks to Eighteenth-street Bridge, was opened and put in good condition. An addition to engine-house, north side, was built to hold the electric-light engine and dynamo. In December, 1886, the electric plant was received and put in successful operation. Four new friction-rollers, cast-iron housings, were put in lower gates, and two rollers in upper gates. New well-hole frames were put in old locks. One of the old scows was cut down, a new bottom and deck made to it, making a good and substantial barge for carrying coal used by the dredges. The dwelling of assistant superintendent was thoroughly repaired, the repairs consisting of new floors in three rooms, repainting and graining, repapering, etc. The office at locks was repainted and calcimined. The timber belonging to falls of Ohio River, that was piled on south side of canal, was removed from slopes to the top of the bank on south side of fence, and is now beyond reach of high water; a great deal of this timber has been lost by high water, and is considerably damaged, and would have become entirely unfit for use had it not been removed. The old wrought and cast iron which has been accumulating for years was sold at auction on March 4, 1887, bringing $1,546.22. The old floor over Eighteenth-street Bridge was replaced by a new one. The steam-pipe on lock-wall, south side, connecting engine-house with upper gates, was placed under ground, inclosed in terra-cotta pipe. The enlarging of canal-basin has been commenced, and is now well under way. This has necessitated the removal of the store-house belonging to the Falls of Ohio River, the framing-shed, carpenter-shops, and other buildings. The osage-orange hedge on south side of canal from Fourteenth street to the locks was cut and trimmed during last August and September (1886). The picket-fence has been kept in repair. Four new spuds have been put on dredges. Four new ladders, two long and two short, have been made for use of diver and general use. The towboat *Walker Morris* has been recently put in working order, and is now fit for service. In addition to work mentioned, a great many needed repairs were made to boats, houses, machinery, etc., and all the daily routine of labor was attended to by the employés and hired laborers. On account of the duration of time of high water the deposit of mud during the year has been very large, amounting to over 4 feet in the locks and in the upper part of canal. On account of heavy coal runs but little has been done towards removing the mud, but will possibly be able to remove it during the next month from the canal and locks. The anchor-bolt that holds the back suspension rod of upper gates, new locks, south side, was showing signs of pulling up, and a new one was put in. A new hog chain was placed in old locks. New frames were put down for windlasses of dry-dock. New grate-bars were placed in boilers and lowered so as to produce more steam, which was required for electric-light engine. During the coming fiscal year a new dredge should be provided to take the place of the old dredge, No. 1. This dredge, by a thorough overhauling, could be made to do service for several years, and would render valuable service, to be used when the other dredges would be laid up for repairs, and even three dredges can at certain times of the year be used to advantage. The guard-gates of both old and new locks are not in good condition, and should be replaced by new ones. The walls of the lower locks in old canal should be raised between the gates, or two small abutments placed on both sides, so as to prevent boats from catching on the walls. The Thenard shutters will require repairing. The apron-dam extending from the wall requires an entire new set of top logs and a new covering. A new tower is needed for the bell, as the present one is about ready to fall. New lintels for chain-drums of lower gates are needed. An entire new set of chains for the gates will be needed, as those now in use are greatly worn and frequently breaking, thereby causing delay in passage of boats. The storeboat requires considerable repair. The warehouse of the canal will require a new roof. The concrete on lock-walls, new canal, is considerably broken, and should be repaired. Attached find tables giving receipts and expenditures, commerce passing Falls of Ohio River and Louisville and Portland Canal, and all the necessary tables composing the annual report.

Very respectfully, your obedient servant,

THOMAS H. TAYLOR,
Superintendent Louisville and Portland Canal.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

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Analytical table showing amount and cost of excavation by dredges during the fiscal year ending June 30, 1887.

Time—		
Lost by high water	days..	88
Lost by ice	do....	20
Lost by Sundays and national holidays	do....	53
Lost by repairs	do....	15
Lost by coal runs	do....	13
At work	do....	176
Total		365
Work:		
Cubic yards excavated		106,720
Per day		606
Cost:		
Salaries (per day, $27.43) for the year		$10,013.00
Repairs and supplies (per day, $78.06) for the year		2,849.44
Total		12,862.44
Cost per actual working day		$73.08
Cost per cubic yard excavated		.12

Detailed statement of dredging for the fiscal year ending June 30, 1887.

Month.	Number of working days.	Lost by high water.	Lost by ice.	Sundays and holidays.	Lost by repairs.	Lost by coal runs.	Total number of days lost.	Number of days at work.	Amount of excavation.
1886.									*C. yd's.*
July	26	.....	.....	5	.....	.....	5	26	13,360
August	26	.....	.....	5	.....	.....	5	26	12,160
September	26	.....	.....	4	.....	.....	4	26	13,080
October	26	.....	.....	5	.....	.....	5	26	19,440
November	26	6	.....	4	.....	.....	10	20	11,760
December	27	14	9	4	.....	.....	27	4	120
1887.									
January	26	15	11	5	.....	.....	31	.....	.....
February	24	24	.....	4	.....	.....	28	.....	.....
March	27	12	.....	4	5	3	24	7	4,560
April	26	9	.....	4	5	3	21	9	7,360
May	26	8	.....	5	1	7	21	10	11,480
June	26	.....	.....	4	4	.....	8	22	22,800
Totals	312	88	20	53	15	13	189	176	106,720

Comparative statement of dredging Louisville and Portland Canal, 1882–'87.

Date.	Total cubic yards.	Total cost, repairs, salaries and supplies.	Daily average of excavation.	Average daily cost.	Number of days at work.
			Cubic yds.		
1882–'83	111,916	$18,382.39	571	$50.36	196
1883–'84	100,760	14,148.30	458	38.76	220
1884–'85	79,975	21,298.27	457	58.35	175
1885–'86	102,312	15,369.31	522	42.13	196
1886–'87	106,720	12,862.44	606	35.24	176

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Statement of vessels passed through the Louisville and Portland Canal, Kentucky, during the fiscal year ending June 30, 1887, with number and tonnage, and amount of coal, iron ore, steel rails, lumber, salt, oil, cotton, whisky, and tobacco.

Date.	Passenger-boats.		Tow-boats.		Model barges.		Coal-boats.		Square barges.		Government boats.		Number of small craft.	Number of rafts.	Total.	
	Number.	Under tonnage.	Number.	Under tonnage.	Number.	Under tonnage.	Number.	Measured capacity.	Number.	Measured capacity.	Number.	Under tonnage.			Number.	Tonnage.
1886.																
July	81	33, 801	118	12, 567	38	12, 520	74	31, 820	214	39, 846	12	627	16	1	554	131, 181
August	79	31, 909	80	6, 767	19	6, 305	3	1, 290	144	23, 240	30	1, 984	26	1	382	71, 495
September	99	24, 986	56	3, 658	3	654	...	.....	88	10, 959	2	112	21	1	270	40, 369
October	95	17, 594	55	3, 562	1	306	3	1, 290	88	11, 988	3	450	42	1	288	35, 190
November	51	11, 496	58	5, 888	5	1, 255	36	45, 696	94	14, 842	16	1, 596	37	..	297	80, 773
December	60	27, 234	88	12, 394	22	6, 708	127	51, 298	278	56, 958	1	424	....	..	576	155, 016
1887.																
January	19	10, 072	33	6, 820	3	1, 049	92	37, 054	67	14, 236	...	.....	....	..	214	69, 231
February	...	.....	...	.....	...	.....	...	.....	...	.....	...	.....	....	..	...	.....
March	34	14, 684	39	12, 189	16	4, 951	80	32, 680	107	22, 978	10	631	5	..	290	88, 113
April	64	26, 426	62	7, 203	29	8, 584	77	33, 310	216	44, 187	11	644	15	3	477	120, 354
May	58	26, 817	126	15, 582	53	17, 583	119	51, 170	254	51, 060	31	1, 812	9	..	650	164, 084
June	60	28, 484	132	17, 339	55	15, 793	160	68, 311	339	70, 613	13	904	9	2	770	201, 444
Total	700	253, 533	847	103, 969	244	75, 708	771	353, 919	1, 889	360, 907	129	9, 214	180	9	4, 768	1, 157, 250

Date.	Lumber.	Coal.	Oil.	Steel rails.	Iron ore.	Salt.	Cotton.	Whisky.	Tobacco.	Lockages.
1886.	*Feet.*	*Bush.*	*Bbls.*	*Tons.*	*Tons.*	*Bbls.*	*Bales.*	*Bbls.*	*Hhds.*	*No.*
July	899, 900	154, 640	5, 181	.....	33, 007	15, 093	3, 018	1, 269	2, 214	471
August	400, 200	94, 800	3, 442	1, 500	2, 883	6, 951	67	910	1, 589	404
September	486, 050	23, 058	1, 898	.....	5	854	3	414	804	342
October	445, 950	4, 005	618	.....	46	914	329	274	289	350
November	248, 000	4, 050, 000	315	.....	10	4, 770	549	134	169	301
December	1, 102, 300	4, 826, 000	4, 235	1, 800	6, 818	10, 544	7, 429	671	206	340
1887.										
January	124, 000	4, 414, 500	18, 141	.....	1, 355	1, 102	2, 921	292	578	116
February	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
March	1, 012, 430	2, 654, 000	2, 975	4, 500	2, 024	2, 415	7, 232	384	316	175
April	696, 160	814, 000	3, 847	.....	4, 276	3, 867	1, 084	740	736	326
May	866, 400	5, 560, 750	9, 262	4, 512	10, 618	12, 349	8, 378	1, 511	2, 187	376
June	1, 182, 500	3, 255, 050	3, 070	16, 450	5, 442	16, 936	3, 786	844	2, 782	535
Total	7, 463, 890	25, 850, 801	53, 004	28, 762	66, 479	75, 795	34, 796	7, 443	11, 880	3, 736

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Detailed statement of vessels passed over the falls of the Ohio, with number, tonnage, amount of coal, iron ore, salt, steel rails, etc., for the fiscal year ending June 30, 1887.

[Navigable days: Ascending, 61; descending, 142. Total, 203.]

DESCENDING VESSELS.

Date.	Passenger-boats.		Tow-boats.		Model barges.		Coal-boats and square barges.		Salt.	Iron ore.	Steel rails.	Coal.	Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Measured capacity.					Number.	Tonnage.
1886.									*Bbls.*	*Tons.*	*Tons.*	*Bush.*		
July														
August							3	434					3	434
September														
October														
November	16	10,483	21	4,563	7	4,150	40	26,280				706,000	84	45,476
December	30	16,552	6	930			17	4,940				19,623	53	22,422
1887.														
January	18	10,940	26	5,101			69	51,322				1,334,000	113	67,363
February	50	26,959	73	15,996	17	12,800	249	179,181			9,900	4,292,000	389	234,856
March	40	22,570	74	14,772	8	6,150	237	148,066	3,800	3,000	1,800	3,706,000	359	191,558
April	28	15,868	88	23,048	22	15,653	506	312,056	8,400	1,740	6,000	8,628,000	644	366,625
May	30	16,503	18	3,166	11	8,800	53	23,190			5,000	492,000	112	51,659
June	21	9,309	1	226			14	2,016					36	11,551
Total	233	129,184	307	67,802	65	47,553	1,188	747,433	12,200	4,740	22,700	19,177,623	1,793	991,974

ASCENDING VESSELS.

Date.	Passenger-boats.		Tow-boats.		Model barges.		Coal-boats and square barges.		Iron ore.	Coal.	Total.		Aggregate.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.	Number.	Measured capacity.			Number.	Tonnage.	Number.	Tonnage.
1886.									*Tons.*	*Bush.*				
July														
August	13	6,216									13	6,216	16	6,650
September														
October														
November	2	1,627	8	1,788							10	3,415	94	48,891
December													53	22,422
1887.														
January	7	4,033	23	4,341			24	13,889			54	22,263	167	89,626
February	49	28,045	66	11,895	9	7,200	58	22,346		24,000	182	67,486	571	302,372
March	29	17,873	73	18,182	9	7,200	153	91,449	1,500	24,000	264	134,704	623	326,262
April	18	11,016	70	14,871	1	800	39	23,396		24,000	128	50,083	772	416,708
May	3	2,681	8	1,987			5	1,672			16	6,340	128	57,999
June													36	11,551
Total	121	69,491	248	53,064	19	15,200	279	152,752	1,500	72,000	667	290,507	2,460	1,282,481

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Commerce passing the falls of the Ohio by canal and by river.

Date.	Through canal.		Descending open river.		Ascending open river.		Total.	
	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.
1880-'81	4,196	1,124,838	1,220	377,055	503	140,306	5,919	1,642,199
1881-'82	3,964	904,343	1,793	537,906	750	220,965	6,507	1,663,214
1882-'83	4,954	1,226,455	1,294	398,240	179	61,802	6,427	1,686,497
1883-'84	4,346	1,070,650	1,384	432,575	301	98,757	6,031	1,601,982
1884-'85	4,886	1,217,231	708	231,695	95	24,320	5,689	1,473,246
1885-'86	5,057	1,254,342	1,290	408,619	373	102,536	6,726	1,765,497
1886-'87	4,768	1,157,250	1,793	991,974	667	290,507	7,228	2,439,731

There passed through canal and open river during the fiscal year ending June 30' 1887, the following items of commerce:

Coal	bushels..	45,100,424
Lumber	feet..	7,463,890
Iron ore	tons..	72,719
Steel rails	do....	51,462
Oil	barrels..	53,004
Salt	do....	75,795
Whisky	do....	7,443
Cotton	bales..	34,796
Tobacco	hogsheads..	11,880
Total value of imports at this port for the fiscal year ending June 30, 1887.		$576,279.00
Total duties collected June 30, 1887		$318,383.34

LOUISVILLE AND PORTLAND CANAL—DRAINAGE RIGHTS.

WAR DEPARTMENT,
Washington City, December 22, 1886.

The Secretary of War has the honor to transmit to the House of Representatives a report of the Chief of Engineers, U. S. Army, dated July 17, 1885, in response to the resolution of the House of Representatives of July 9, 1885, as follows:

Whereas by the terms of the joint resolution of the legislature of the State of Kentucky, approved March 28, 1872, transferring the control and management of the Louisville and Portland Canal to the Government of the United States, it is expressly provided that the right of drainage into said canal is reserved to the city of Louisville; and

Whereas it is reported that the United States engineers in charge of said canal have objected to the exercise of that right upon the part of the city of Louisville; Therefore,

Resolved, That the Secretary of War be, and is hereby, directed to report to Congress whether, in his judgment, said right of drainage should be conceded to the city of Louisville, and, if not, the reason therefor, together with such information upon the subject as may to him seem proper in the premises.

The report of the Chief of Engineers is accompanied with report of Maj. Amos Stickney, the officer of the Corps of Engineers in charge of the Louisville and Portland Canal, and its accompanying papers.

The Louisville and Portland Canal Company was incorporated by an act of the legislature of Kentucky approved January 12, 1825.

By an act of the Kentucky legislature approved February 21, 1842, amending the charter of the canal company, the board of president and directors of the canal company were authorized, when so directed by the stockholders thereof, to sell "the shares of stock owned by individuals in said canal to the United States." * * *

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By an act of the Kentucky legislature approved February 22, 1844, further amending the charter of Louisville and Portland Canal, it was declared—

That in the event of the United States becoming the sole owner of the Louisville and Portland Canal, the jurisdiction of this Commonwealth over said canal shall be yielded up to the Government of the United States.

On February 8, 1855, the Secretary of the Treasury informed the President that "the canal, with the exception of five shares, is now the property of the United States. * * *" The board of president and directors of the canal had, by the Secretary of the Treasury, been requested, each, to retain one share of the stock of the company, in order that no difficulty might arise in the management of the work.

From 1868 to 1873 the Congress of the United States made a series of appropriations for increasing the capacity of the canal.

On the 28th day of March, 1872, the legislature of Kentucky passed a joint resolution, which was approved by the governor, by which the president and directors of the Louisville and Portland Canal were directed to surrender the said canal and all the property connected therewith to the Government of the United States, upon certain terms and conditions, one of which was "that the city of Louisville shall at all times have the right of drainage into said canal: *Provided*, That the connections between the drains and the canal shall be made upon the plan to keep out mud and garbage."

In an act of Congress approved March 3, 1873, making appropriations for the repair, etc., of certain public works, etc. (17 Stats., 563), "the Secretary of the Treasury is authorized and directed to assume, on behalf of the United States, the control and management of the said canal, in conformity with the terms of the joint resolution of the legislature of the State of Kentucky approved March 28, 1872, at such time and in such manner as in his judgment the interests of the United States and the commerce thereof may require; * * *."

The Secretary of the Treasury found it impracticable to assume the control of the canal on the terms provided, and in his annual report to Congress of December 1, 1873, explained his action in the premises.

Subsequently, by an act of Congress, approved May 11, 1874, the Secretary of War was directed "to take possession of the said Louisville and Portland Canal, and all the property, real and personal, of the said company, as the property of the United States, as provided for by the act of the general assembly of the State of Kentucky, approved February 22, 1844, * * * conceding jurisdiction over said canal to the United States. * * *." Under this law and the directions of the Secretary of War of May 27, 1874, Major Weitzel, of the Engineer Corps, assumed control of the canal on the 11th of June, 1874. In this act the joint resolution of the legislature of Kentucky of March 28, 1872, is not mentioned, and in its report upon this measure the Committee on Finance of the Senate of the United States, on the 14th of April, 1874, speaks of the conditions contained in this resolution of the Kentucky legislature as "conditions *sought* to be imposed for the local advantage of the city of Louisville."

(1) Assuming that the joint resolution of the State of Kentucky of March 28, 1872, which provides that the city of Louisville may drain into the canal, is in force and binding on the United States, it certainly does not confer upon that city the right to pollute and to render foul the waters of the canal. It appears from the accompanying reports that "the nature of the drainage is surface, house (from water-closets), etc., and from factories of all kinds;" also that "there is no provision made to prevent mud and garbage from entering the sewers except the

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street catch-basins, which are trapped," and that during the months of July, August, and September "the canal becomes very offensive, especially after heavy rains, which wash the streets and flush the sewers, carrying large quantities of filth and sediment into the canal." It certainly could not have been intended by this provision in regard to drainage, which carefully excludes garbage, that all the sewage of the city should pass into the canal, thus rendering it a common nuisance.

(2) But it is not conceded that the United States took this canal subject to such restriction upon its use. The control of the canal was assumed by the Secretary of War, under the act of Congress of May 11, 1874, as provided for by the act of the general assembly of the State of Kentucky approved February 22, 1844, conceding jurisdiction over said canal to the United States. Under this act and not under the joint resolution of March 28, 1872, the United States now hold and occupy this property. It would therefore seem to be clear that the terms of the joint resolution can not impose any conditions upon the United States or vest in the city of Louisville any right or privilege of draining into the canal.

WILLIAM C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 17, 1886.

SIR: I have the honor to acknowledge the reference to this office, on the 10th ultimo, of the preamble and resolution of the House of Representatives, dated the 9th June last, in reference to the drainage of the city of Louisville, Ky., into the Louisville and Portland Canal, and its right to do so, and directing the Secretary of War "to report to Congress whether in his judgment said right of drainage should be conceded to the city of Louisville, and if not, the reason therefor, together with such information upon the subject as may to him seem proper in the premises."

In reply I beg to invite attention to the accompanying copy of the report thereon from Maj. Amos Stickney, Corps of Engineers, which, with its inclosures, will, it is believed, furnish the required information.

Major Stickney states:

> It appears from the terms of the recent resolution of the House of Representatives, and the letter of the acting city engineer, dated June 19, 1886, a copy of which is herewith, that the city rests its claim to drain into the canal upon the joint resolution of the Kentucky legislature alone, and as the United States accepted the canal under other State legislation and not under that resolution, the resolution can have no force in binding the United States.

Major Stickney further says:

> There is no question in my mind that the city drainage should not enter the canal.

His views are worthy of consideration, and his report is commended accordingly.

The resolution of the House of Representatives is herewith respectfully returned.

Very respectfully, your obedient servant,

JOHN NEWTON,
Chief of Engineers,
Brig. and Bvt. Maj. Gen.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

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REPORT OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, ON DRAINAGE OF THE CITY OF LOUISVILLE, KENTUCKY, INTO THE LOUISVILLE AND PORTLAND CANAL.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 29, 1886.

GENERAL: In compliance with instructions of the Engineer department in indorsement of June 11, 1886, upon the resolution of the House of Representatives, dated June 9, 1886, relating to the right of the city of Louisville, Ky., to empty its drainage into the Louisville and Portland Canal, I have the honor to make the following report:

The original act of the general assembly of the Commonwealth of Kentucky to incorporate the Louisville and Portland Canal Company, approved January 12, 1825, and the various additional enactments under which the canal was constructed, contains no provision for, or allusion to, the right of the city of Louisville to empty its drainage into the canal, and the original act of January 12, 1825, contains the following section, which might be construed as forbidding such drainage into the canal:

SEC. 10. That if any person or persons shall wilfully and knowingly do any act or thing whatever whereby the said navigation or any lock-gate, dam, engine, machine, or other thing thereto belonging shall be injured or damaged or impeded, or shall commit any willful trespass, or take, carry away, or conceal any material, instrument, tool, or other thing belonging to or used in or about the said works, or shall open or cause the locks to be opened, or attempt so to do, or to pass or repass without the knowledge of the agent or manager to said canal, he, she, or they so offending shall forfeit and pay to the said canal company, their tenant or agent, three times the amount of the cost of damage sustained by means of or through such willful act, together with costs of suit, to be received before any court of competent jurisdiction, and in case of clandestinely taking and carrying away be liable to a prosecution for theft, as in other cases.

I doubt if at that time it was at all contemplated to make the still water of the canal the receptacle of the offensive matter thrown off by the city, to remain along the city front, and rot and corrupt the air under the hot summer sun.

The National Congress early took an interest in the canal, and by act approved May 13, 1826, authorized the Secretary of the Treasury to purchase a considerable amount of the stock of the canal company, and by subsequent acts increased the holding of the United States. By act approved January 21, 1842 (copy herewith), the general assembly of the Commonwealth of Kentucky authorized the sale and transfer of the canal to the Government of the United States, the only conditions being that the Government should levy tolls only sufficient to keep the canal in repair, pay all necessary superintendence, custody and expenses, and make all necessray improvements, so as fully to answer the purposes of its establishment; and, further, that the agents in charge should make certain reports to the general assembly of Kentucky, which reserves certain rights of regulating the amount of tolls. An act of the Kentucky assembly approved February 22, 1844 (copy herewith), amended the above act of January 21, 1842, so as to yield jurisdiction to the United States and relinquish the requirement concerning reports. It is under this last amendatory act of February 22, 1844, that the United States took possession of the canal by authority granted the Secretary of War in act of National Congress approved May 11, 1874 (copy herewith).

On March 28, 1872, the Kentucky legislature passed a joint resolution (copy herewith) authorizing and directing the officers of the canal company to surrender the canal to the United States Government on cer-

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tain conditions, one of which was "that the city of Louisville shall at all times have the right of drainage into said canal: *Provided*, That the connections between the drains and the canal shall be made upon the plan to keep out mud and garbage."

The river and harbor act of the National Congress, approved March 3, 1873, contained a clause (copy herewith) authorizing and directing the Secretary of the Treasury to assume the control and management of the canal, in conformity with the terms of the above joint resolution of the Kentucky legislature; but no action was taken by the Secretary of the Treasury in assuming control. It will thus be seen that the joint resolution of the Kentucky legislature of March 28, 1872, is the first and only legislation of the State that contains any reference to right of drainage into the canal, and the management of the canal by the United States was not assumed under the terms of that resolution, but under the terms of the State act of 1844, amending that of 1842, which did not give the city of Louisville the right of drainage into the canal.

It appears from the terms of the recent resolution, June 9, 1866, of the House of Representatives, and the letter of the acting city engineer, dated June 19, 1886, a copy of which is herewith, that the city rests its claim to drain into the canal upon the joint resolution of the Kentucky legislature alone; and as the United States accepted the canal under other State legislation, and not under that resolution, the resolution can have no force in binding the United States.

It appears to me, therefore, that the city of Louisville has no right to drain into the canal under the authority of any legislative action, either State or National. The question then arises, If there is no right, is there any reasonable objection?

I would call attention to the inclosed reports of Mr. C. L. Cornwell, assistant superintendent, and Mr. J. G. Durbeck, detailing some of the objections and giving analyses of the canal water made in 1876, which are immediately available. As the city increases in population, of course the organic and other deleterious matter has and will continue to increase in amount. I inclose herewith a tracing showing the river front, the canal, and adjacent streets, with their sewers. From an inspection of this map it will be seen that there now exist a number of sewers and drains that empty into the canal and river just above. When the river water surface is low enough, during the dry hot season of the year, to prevent any flow over the dam at the head of the canal, all of the sewage as high up as Fourth street, and possibly as far up as Preston street, must flow into water which is almost stagnant, and which is drawn into the canal by the process of locking. From Preston street to the foot of the locks is a distance of about 3 miles, and the drainage that would be emptied into this, if unrestrained, would be that from at least eleven hundred and nine acres of city ground. (See letter of city engineer.) It is hardly necessary, I imagine, to adduce proof of the ill results that might be expected from the impounding of such a quantity of the decaying and fetid matter that is constantly cast off by a populous city. The health of the employés of the canal, the durability of the various structures in it, and the health and well-being of all the inhabitants of the portion of the city fronting the canal, would undoubtedly be seriously affected.

There is no question in my mind that the city drainage should not enter the canal.

The question then arises, If the city is debarred from emptying its drainage along 3 miles of its river front, where and how can it dispose of the drainage?

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There are at least two possible solutions of this problem. One is to continue the sewers and drains or a sufficient number of them across the line of the canal to proper points in the river. This would probably be the most costly, least satisfactory, and most difficult. The other plan would be to construct an intercepting sewer inside of the canal line, extending from a point far enough above the canal to intercept all drainage that could enter the canal, to such a distance on the river below the canal as to insure reaching a constant river current. Either plan would involve the expenditure of a considerable amount of money. The source from which this money should come is a matter which, perhaps, I am not called upon to discuss. A few remarks, however, may not be amiss or inappropriate. It has been a custom pretty generally observed by cities fronting upon a large stream of water having a constant and considerable current to empty their drainage into the stream in the most direct manner possible, as being the least expensive, most advantageous, and healthful manner of disposing of all noxious material, which, if allowed to remain, would affect the health, happiness, and general prosperity of the people.

The city of Louisville is so situated with regard to the Ohio River as to make this the natural method; but for a distance of over 2½ miles it is cut off from direct connection with the river by a large public work, which is used by and maintained for the general public. The existence of this public work and the inadvisability of permitting it to be used for drainage purposes makes it necessary for the city to adopt some method for disposing of its sewage, which is expensive and burdensome.

I presume there is no doubt of the right of the city to drain into the river above the canal, although such drainage would enter the canal. Under the circumstances there would, in my opinion, be no impropriety in the General Government affording some relief.

The following inclosures are sent herewith:

Copy of act of general assembly of Commonwealth of Kentucky approved January 21, 1842.
Copy of act of general assembly of Commonwealth of Kentucky approved February 22, 1844.
Copy of joint resolution of the Kentucky legislature, dated March 28, 1872.
Copy of act of Congress approved March 3, 1873 (extract).
Copy of act of Congress approved May 11, 1874.
Copy of letter of Major Stickney to the mayor of Louisville, Ky.
Copy of letter from assistant city engineer of Louisville, Ky.
Copy of report from C. L. Cornwell.
*Tracing of map of Louisville and Portland Canal, etc.
Copy of report of J. G. Durbeck.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

AN ACT to amend the charter of the Louisville and Portland Canal Company.

SECTION 1. *Be it enacted by the general assembly of the Commonwealth of Kentucky*, That the act incorporating the Louisville and Portland Canal Company shall be, and the same is hereby, so amended that whenever the stockholders in said company shall so direct, the board of president and directors of said company shall have the privilege of selling the shares of stock owned by individuals in said canal to the United States, or the State of Kentucky, or the city of Louisville, for the purpose of eventually making the said canal free of tolls; or, further to effect this object, the board of

*Omitted. Printed in House Ex. Doc. No. 51, Forty-ninth Congress, second session.

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president and directors, when so authorized as aforesaid, shall hereby have the privilege of appropriating the net income arising from said canal to the purchase of said stock instead of making dividends therewith.

SEC. 2. *Be it further enacted*, That whenever said stockholders shall authorize said board of president and directors to appropriate the annual net income of said company to the purchase of shares held by individuals in the same, it shall be the duty of said board to advise each stockholder of the amount to be appropriated to the purchase of shares, and propose to purchase the number of shares that the sum on hand will warrant, at the lowest bid or offer. Thirty days' notice shall be given for such offers of stock to be made.

SEC. 3. *Be it further enacted*, That the maximum price at which the said board shall purchase said shares for the first year shall not exceed the sum of one hundred and fifty dollars per share, and when the offers of said shares are made it shall be the duty of said board to accept the lowest offers for the number of shares which the net income of the preceding year will allow them to purchase; and no dividends will be paid on the remaining shares of said company after the ratification of this amended act; the maximum price paid for the shares purchased the first year and six per cent. per annum annually added thereto shall be the highest price which shall be paid for the shares in each subsequent year.

SEC. 4. *Be it further enacted*, That the shares so purchased by said board shall be held in trust by it for the purposes herein declared, and shall be voted on by them at all subsequent meetings and elections, until by the operation of the provisions of this act all the shares standing in the name of others than the Government of the United States shall have been purchased up; and when the said shares shall be all purchased the same shall be transferred to the Government of the United States, on condition of said Government levying tolls for the use of said canal only sufficient to keep the same in repair and pay all necessary superintendence, custody, and expenses, and make all necesary improvements, so as fully to answer the purposes of its establishment; and further to protect and guard the interests of commerce, the superintendents or agents in charge of said canal shall ever hereafter, on the first Monday in January annually, report to the general assembly of Kentucky the amount of tolls levied and received, and of the charges and expenses incurred on the same, the general assembly reserving the right of directing the amount annually to be collected, if found too much for the purposes contemplated by this amended act.

SEC. 5. *Be it further enacted*, That it shall be the duty of said board of president and directors to report to this general assembly, on the first Monday in January in each year, the condition of the canal and state the number of shares purchased and the amount paid for the same: *Provided*, That nothing contained in this act shall give said company the right to increase the toll allowed by the original charter.

Approved, January 21, 1842.

AN ACT to amend an act entitled "An act to amend the charter of the Louisville and Portland Canal Company," approved January 21, 1842.

Be it enacted by the general assembly of the Commonwealth of Kentucky, That in the event of the United States becoming the sole owner of the Louisville and Portland Canal, the jurisdiction of this Commonwealth over said canal shall be yielded up to the Government of the United States, and no annual report, as mentioned in the charter of the Louisville and Portland Canal Company, shall be required to be made by the United States, or the agents and superintendents of said canal to the general assembly of this Commonwealth.

Approved, February 22, 1844.

JOINT RESOLUTION of the Kentucky legislature, March 28, 1872.

Whereas all the stock in the Louisville and Portland Canal belongs to the United States Government except five shares owned by the directors of the Louisville and Portland Canal Company, and said directors, under the authority of the legislature of Kentucky and the United States, executed a mortgage to Isaac Caldwell and Dean Richmond to secure bonds named in said mortgage, some of which are out and unpaid, and said canal company may owe other debts; and

Whereas it is right and proper that the Government of the United States should assume the control and management of said canal: Therefore, be it

Resolved by the general assembly of Kentucky, That the president and directors of the Louisville and Portland Canal Company are hereby authorized and directed to sur-

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render the said canal and all the property connected therewith to the Government of the United States, upon the following terms and conditions:

1. That the Government of the United States shall not levy tolls on said canal, except such as shall be necessary to keep the same in repair, pay all necessary superintendence, custody, and expenses, and make all necessary improvements.

2. That the city of Louisville shall have the right to throw bridges over the canal at such points as said city may deem proper: *Provided always*, That said bridges shall be so located as not to interfere with the use of the canal, and so constructed as not to interfere with its navigation.

3. That the title and possession of the United States of said canal shall not interfere with the right of the State to serve criminal and civil processes, or with the State's general police power over the territory covered by said canal and its appendages.

4. *And further*, That the city of Louisville shall at all times have the right of drainage into said canal: *Provided*, That the connections between the drains and the canal shall be made upon the plan to keep out mud and garbage.

5. That the use of the water-power of the canal shall be guaranteed forever to the actual owners of the property contiguous to said canal, its branches and dams, subject to such restrictions and regulations as may be made by the Secretary of the Department of the United States Government which may have charge of the said canal.

6. That the Government of the United States shall, before such surrender, discharge all the debts due by said canal company, and purchase the stock of said directors.

AN ACT making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

* * * * * * *

For completing the Louisville and Portland Canal, one hundred thousand dollars; and the Secretary of the Treasury is authorized and directed to assume, on behalf of the United States, the control and management of the said canal, in conformity with the terms of the joint resolution of the legislature of the State of Kentucky, approved March twenty-eighth, eighteen hundred and seventy-two, at such time and in such manner as, in his judgment, the interests of the United States, and the commerce thereof, may require; and the sum of money necessary to enable the Secretary of the Treasury to carry this provision into effect is hereby appropriated. *Provided*, That after the United States shall assume control of said canal the tolls thereon on vessels propelled by steam shall be reduced to twenty-five cents per ton, and on all other vessels in proportion.

* * * * * * *

Approved March 3, 1873.

AN ACT providing for the payment of the bonds of the Louisville and Portland Canal Company.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the appropriations made by the act approved March third, eighteen hundred and seventy-three, entitled "An act making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes," for the payment of the debts of the Louisville and Portland Canal Company, are hereby continued in full force, and are made permanently applicable to the payment of the debts of the said Louisville and Portland Canal Company, and so much as may be necessary shall be applied to the payment of the interest as it accrues and the principal of the outstanding bonds of said company as they mature: *Provided, however*, That the Secretary of the Treasury may purchase and pay for any of said bonds at the market price, not above par, whenever he deems it for the interest of the United States.

SEC. 2. That after thirty days from the passage of this act, the Secretary of War is hereby authorized and directed to take possession of the said Louisville and Portland Canal and all the property, real and personal, of said company as the property of the United States, as provided for by the act of the general assembly of the State of Kentucky, approved February 22, 1844, entitled "An act to amend an act entitled 'An act to amend the charter of the Louisville and Portland Canal Company,' approved January 21, 1842," conceding jurisdiction over said canal to the United States, subject, however, to the mortgage lien on said property in favor of the trustees under said

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mortgage, and the holders of the bonds issued under it; and the Secretary of the Treasury is hereby authorized to pay the directors of said company for the stock held by them, which payment shall be made forthwith by the Secretary of the Treasury, being the sum of $100 to each director, with interest thereon at 6 per centum per annum since the 9th day of February, 1864; and he is authorized and directed to cause a careful and full examination of all the receipts and disbursements of the said company to be made, and to collect, and, if necessary, to sue for any money due to or held for the said company by the directors of said company, or the trustees under said mortgage, or by any persons whatever. And said Secretary of the Treasury is hereby directed and empowered, immediately upon the passage of this act, to give public notice, in such manner as in his judgment will best effect the purpose, to all persons and corporations having debts of any nature against said Louisville and Portland Canal Company, except the bonded debt thereof, to present them to him on or before the first day of July, eighteen hundred and seventy-five, and any such debt not presented on or before said day shall be forever barred. And said Secretary is hereby directed and authorized to examine, audit, and in his discretion, allow such debts or any of them, being hereby vested with any power necessary to that end; and he shall embrace his action in the premises in his succeeding annual report: *Provided, however*, That no sum of money shall be paid by the Secretary of the Treasury on account of any claim for either city or State taxes, assessed or to be hereafter assessed, against said company, or against the said canal property, or any of its appendages.

SEC. 3. That the said canal and property appertaining thereto shall be held for the common use and benefit of the people of the United States, free of all tolls and charges except such as are necessary to pay the current expenses of said canal and to keep the same in repair, and for the present year they shall be at the rate of 10 cents per ton capacity on vessels propelled by steam and 5 cents per ton on other vessels; and to ascertain what rates will pay current expenses after the present year, the Secretary of War shall, on the first Monday of January of each year, ascertain from the expenses of the previous year what tolls will probably pay the expenses of the current year, and shall fix and declare the rate of tolls thus ascertained to be charged for the current year; and, until otherwise provided by law, the Secretary of War shall provide for the superintendence, management, and repair of said canal, and may apply the tolls so received, as far as may be necessary, to pay the current expenses of said canal and he shall, in his next annual report, set forth such receipts and expenditures, and the condition of said canal, with a view to such legislation as may be necessary for the superintendence and management thereof; but no expenditure nor contract for expenditure of money shall be made under the authority of this section in any one year to an amount greater than the amount which may be received during such year from the tolls on said canal.

SEC. 4. That if at any time it become necessary to enforce the lien of the mortgage upon said canal property for the benefit of the bond holders, it shall be lawful for the trustees named in said mortgage, or any other trustees who may be appointed in pursuance of the laws of Kentucky, to commence proceedings therein in any court having jurisdiction thereof, with notice to the United States as terre tenant pro forma, and serve process upon any officer of the United States who shall have the superintendence of said canal, whose duty it shall be to notify the Attorney-General of the United States of such service; whereupon said Attorney-General shall enter an appearance in said case, and take all necessary steps to represent and defend the interests of the United States in such proceedings, so that the same may be conducted in the same manner and with the like effect as if the said Louisville and Portland Canal Company were still in existence as a corporation.

Approved, May 11, 1874.

LETTER OF MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, TO THE MAYOR OF THE CITY OF LOUISVILLE, KENTUCKY, RELATING TO DRAINAGE.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., June 15, 1886.

SIR: I am directed by the Chief of Engineers, United States Army, to report upon a resolution of the National House of Representatives relating to the right of the city of Louisville to empty its drainage into the Louisville and Portland Canal.

The resolution is as follows.

"Whereas, by the terms of the joint resolution of the legislature of the State of Kentucky, approved March 28, 1872, transferring the control and management of the Louisville and Portland Canal to the Government of the United States, it is expressly provided that the right of drainage into said canal is reserved to the city of Louisville; and, whereas, it is reported that the United States engineers in charge of said

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canal have objected to the exercise of that right upon the part of the city of Louisville: Therefore,

"*Resolved*, That the Secretary of War be, and is hereby, directed to report to Congress whether in his judgment said right of drainage should be conceded to the city of Louisville, and, if not, the reason therefor, together with such information upon the subject as may to him seem proper in the premises."

In order that I may comply with my instructions, I would respectfully request to be informed upon the following points:

Upon what ground does the city claim the right of drainage into the canal?

What drainage does the city now empty, or in future might it contemplate emptying, either into the canal or at points that would make it liable to enter the canal?

What are the dimensions of the sewers or drains?

What area do they drain?

What is the nature of the drainage?

Are any provisions made to prevent mud and garbage from entering the canal?

Any other information upon the subject which you may present will be very acceptable.

Yours, very respectfully,

AMOS STICKNEY,
Major of Engineers.

Hon. P. B. REED,
Mayor of the city of Louisville, Ky.

LETTER FROM SAMUEL B. RANKIN, ASSISTANT CITY ENGINEER OF LOUISVILLE, KY., IN REGARD TO SEWAGE AND DRAINAGE.

OFFICE OF CITY ENGINEER, ROOM NO. 42, CITY HALL,
Louisville, Ky., June 19, 1886.

DEAR SIR: Your letter of 15th to the mayor has been referred to this department for answer. In the absence of Mr. Scowden, who will be absent from the city for some weeks, I would answer your questions as follows:

1st. The ground upon which the city claims the right of drainage into the canal is found in section 4 of the resolution (of March 28, 1872) referred to in section 5255, Title LXIII, p. 1021, Revised Statutes United States, March 3, 1873. This resolution is of the Kentucky legislature, and will be found in foot-notes to pages 224 and 225 in "Louisville City Code," 1884.

Answer 2. The sewers that now drain directly into the canal are the Seventeenth street, Twelfth street, and Tenth street sewers.

Those that empty into low ground between High avenue and the canal, and then drain west in ditches to about the mouth of the canal, are the Twenty-seventh street sewer (being the mouth of the Twenty-sixth street sewer) and the Twenty-first street sewer.

The sewers that empty into the river as far east as Fourth street, are the Fourth street, Fifth street, Sixth street, and Eighth street sewers.

Under the law, as I understand it, the general council of the city has the power to pass resolutions for constructing sewers in *any* streets leading to the canal between its head and mouth.

Answer 3. The dimensions of the sewers are:

Twenty-seventh street, 8 feet, circular.

Twenty-first street, 6 feet by 4 feet, egg-shaped.

Seventeenth street, 5½ feet by 3½ feet, egg-shaped.

Twelfth street, 5½ feet by 3½ feet, egg-shaped.

Tenth street, 3 feet, circular.

Eighth street, 3 feet, circular.

Sixth street, 3 feet, circular.

Fifth street, 3½ feet by 5½ feet, egg-shape.

Fourth street, 5 feet by 3 feet, egg-shape.

Answer 4. The area drained by the above-mentioned sewers is 1,109 acres.

Answer 5. The nature of the drainage is surface, house (from water-closets, etc.), and from factories of all kinds.

There is no provision made to prevent mud and garbage from entering the sewers, except the street catch-basins, which are trapped.

Hoping these are full answers to your questions,

I am, very respectfully,

SAM. B. RANKIN,
Assistant City Engineer.

AMOS STICKNEY,
Major of Engineers, U. S. A.

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REPORT OF MR. C. L. CORNWELL, ASSISTANT SUPERINTENDENT UPON THE SEWAGE OF THE CITY OF LOUISVILLE, KY., IN CONNECTION WITH THE LOUISVILLE AND PORTLAND CANAL.

LOUISVILLE AND PORTLAND CANAL OFFICE, *June* 24, 1886.

SIR: In compliance with your order I have the honor to submit herewith the following report accompanied by a map showing the Louisville and Portland Canal and the lands belonging to the United States, with the adjoining portion of the city of Louisville, Ky., showing the present system of sewage, now emptying into the canal proper, also a portion of the district that is drained into the Ohio River immediately above the head of the canal, which also finds its way into the same. This report must necessarily be brief and incomplete in much detail, owing to the very limited time allowed for its preparation. Had more time been given, careful analyses of the water entering the canal at the present time would have been made and compared with others taken from the Ohio River. Inclosed, however, will be found a report by Mr. I. G. Durbeck, a chemist of many years' experience, who has tabulated some analyses made some years ago of water taken from the canal, also from the Ohio River at the same time, for comparison. The analyses show decidedly large quantities of organic matter carried in the water taken from the canal.

The Louisville and Portland Canal was built for the purpose of carrying vessels around the Falls of the Ohio River at Louisville, Ky. The present length of the canal is about 2½ miles and is located immediately adjoining and partly through the city of Louisville, and lies between the city and the Ohio River. The line of the canal passes through low land, the level of which is considerably below the general level of the city.

At present seven main sewers with their numerous branches, and six private sewers or drains discharge directly into the canal, from Fourth street to the locks. At Preston street another sewer empties into the Ohio River, only a short distance above the head of the canal. The greater portion of the discharge from this sewer enters the canal during the months of low water, which extends from about the 1st of July until December, five months, three of which, July, August, and September, embrace the hottest portion of the season in this latitude. At this time of year the canal becomes very offensive, especially after heavy rains, which wash the streets and flush the sewers, carrying large quantities of filth and sediment into the canal. Fishes that chance to get into the canal soon die and can be seen floating on the surface in large numbers, and in a short time are in a decomposed state; they collect at the lock-gates, together with the bodies of small animals, where they become so offensive that the locks have to be opened to dispose of them.

The area drained by the sewers that now empty into the canal will exceed 600 acres, embracing the most populous portion of the city. This area is annually increasing as the sewers are extended. In time the canal will be converted into an immense, open sewer, unless some measures are adopted to entirely remove or at least lessen the present evil.

There can be no question but that the health of those employed on the canal, as well as all compelled to reside in the vicinity, is at times seriously affected by the condition of the water in the canal.

It has been generally considered that the sewage and chemicals used at the paper-mills, now entering the canal, is injurious to the life of gates and other structures, but as yet it has not been clearly demonstrated just what effect can be directly charged to it. The iron work on the gates is found to be badly corroded in a few years, especially those parts continuously submerged.

To determine, if possible, what injurious effect, if any, the water in the canal has upon boilers, I addressed letters to the different firms of this city owning steam-vessels that frequently use the canal. So far only one answer has been received, which is as follows:

"DEAR SIR: Yours of the 19th instant, inquiring as to injurious effect of water in canal on hulls and boilers, received. We have delayed answering until we could consult with some of the officers of the boats.

"The engineers say they can not tell whether the water has any effect on the boilers or not, as they are in the canal so short a time in proportion to the time spent outside and only pump the water of the canal when compelled to do so. The same thing applies to the hulls, though, judging from the effect of the same sewage in a much more diluted state on our wharf-boat, which is exposed to it all the time, the canal water must be very injurious to hulls exposed to it any length of time.

"Very truly,

"W. W. HITE & CO.

"C. L. CORNWELL, Esq.,
"*Assistant Superintendent Louisville and Portland Canal.*"

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In conclusion I desire to call your attention to the letters of Capt. A. Mackenzie, of June 4 and June 7, 1877; Capt. A. N. Lee, Corps of Engineers, dated June 6, 1878; and to the answer of Capt. A. Mackenzie, transmitting a copy of a letter addressed by the Chief of Engineers, General A. A. Humphreys, to the honorable Secretary of War, in which he strongly opposes the attempt of the city authorities to discharge *their sewers* into the canal; also to the letter of Mr. Phil. J. Schopp, superintendent Louisville and Portland Canal, dated February 7, 1883, all of which strongly oppose the entrance of any additional sewers into the canal.

Very respectfully, your obedient servant,

C. L. CORNWELL,
Assistant Superintendent Louisville and Portland Canal.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

REPORT OF J. G. DURBECK RELATING TO ANALYSES OF WATER IN LOUISVILLE AND PORTLAND CANAL.

LOUISVILLE AND PORTLAND CANAL OFFICE,
Louisville, Ky., June 24, 1886.

SIR: I have the honor to submit herewith the following report of analyses of canal and river water:

In 1875 I was ordered by General G. Weitzel, then in charge of the Louisville and Portland Canal and the improvement of the falls of the Ohio, to make a quantitative analyses of the canal water from time to time, so as to ascertain whether any substances were contained in it injurious to iron or wood used in construction of lock-gates or gate machinery. Having previously ascertained large amounts of organic matter in the canal water, I concluded to make at the same time an analysis of the river water for comparison of the organic matter contained in it.

January 17, 1876, 1,000 grams of canal and 1,000 grams of river water were taken.

The canal water yielded:

Organic matter, .071.
Earthy matter, .182.
Iron, .083.
Lime, .092.
Soda, .697.

One thousand grams of river water yielded:

Organic matter, .008.
Earthy matter, .105.
Iron, .099.
Lime, .010.
Traces of chloride of sodium.

On February 24, 1876, 1,000 grams of canal and 1,000 grams of river water were taken.

One thousand grams of canal water yielded:

Organic matter, .255.
Earthy matter, .856.
Iron, .193.
Lime, .088.
Soda, with traces of magnesia, .213.

One thousand grams river water, taken February 24, 1876, yielded:

Organic matter, .007.

On October 22, 1876, after a very long dry season, 1,000 grams of canal and 1,000 grams of river water were taken, twelve hours after a very heavy rain.

The canal water yielded:

Organic matter, .335.
Earthy matter, .197.
Iron, none.
Lime, .068.
Soda, .283.

One thousand grams of river water taken, October 22, 1876, yielded:

Organic matter, .007.

I have never found free acid in the canal water, but have found the water frequently to react alkaline on account of the large quantity of soda used in the paper-mill for cleaning rags, the refuse water emptying into the canal.

Very respectfully, your obedient servant,

J. G. DURBECK.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

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IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS, BELOW VINCENNES.

The river and harbor bill approved August 5, 1886, appropriated $60,000 for continuing work on lock at Grand Rapids and for improving the river from Grand Rapids to its mouth, with a proviso that $9,000 should be expended at Grayville. It was decided to apply $36,000 to the purchase of stone and commencement of construction of the lock at Grand Rapids; as much as was necessary of the $9,000 for the construction of a levee at Grayville, $10,000 for repairs and operating of snag-boat, and $5,000 for contingencies.

LOCK AND DAM AT GRAND RAPIDS.

At the beginning of the year a contract was in force with Carmody & Mapel for the delivery of sufficient stone to build three or four courses of the lock-wall. These contractors have shown themselves utterly unable to fill their contract, and the fifth extension of their time expired July 1, 1887, up to which time they had delivered only 1,543.131 yards of stone. It is hoped now that a contract may be made with parties able to deliver stone with reasonable promptness. Work at the lock-site was commenced with hired labor April 1. The preparatory work, removing deposit from old lock-chamber, removing old lock-walls, constructing a dam, inclosing lock-site, and procuring and placing machinery, has been well advanced, and it is hoped that masonry work may be commenced in a short time.

WORK AT GRAYVILLE.

The incipient cut-off at Grayville had become quite threatening, and it was determined to use the funds provided in constructing or extending a levee which would prevent the flow of water and hold the neck of land for a time, with the hope that additional funds would be provided in time for the protection of the caving banks. The levee has been about completed.

SNAG-BOATS.

The snagging plant had, for want of funds, become very much dilapidated. It has been put in very good condition and will be set to work as soon as possible.

NEW HARMONY CUT-OFF.

The cut around the end of the dam at New Harmony, which was mentioned in last year's report, has considerably increased in depth and width, and it is estimated that fully one-half of the discharge of the river passes through it. It has not been practicable to do any work at this point during the year, on account of insufficiency of funds. When the work is once commenced it should be completed in one season, and it will cost not less than $25,000.

ESTIMATES.

The following table of estimates is presented for important work in this part of the river:

Completing lock and dam at Grand Rapids	$114,000
Work at Widow Goss and Skidmore bars	20,000

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Work at Little Chain	$20,000
Work at Grand Chain	25,000
Protection of bank at Grayville	11,000
Dam at Little Chain Cut-off	2,000
Removal of rock at Marshall's Ferry	1,000
Dam at New Harmony	25,000
Work at Coffee Island Chute	2,600
Channel through White River Shoals	20,000
Repairs to works, maintenance of plant, contingent expenses	10,000
	250,600

The application of any funds that might become available for the next fiscal year would depend upon the amount and would be for the prosecution of work stated in the estimate.

For a statement of the condition of the river and details of work attention is invited to the accompanying report of Mr. O. L. Petitdidier, assistant engineer.

Money statement.

July 1, 1886, amount available	$13,924.60	
Amount appropriated by act approved August 5, 1886	60,000.00	
		$73,924.60
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	22,444.30	
July 1, 1887, outstanding liabilities	5,043.99	
		27,488.29
July 1, 1887, amount available		46,436.31

Amount (estimated) required for completion of existing project	250,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

U. S. ENGINEER OFFICE,
Louisville, Ky., July 25, 1887.

MAJOR: I have the honor to submit the following report on improvement of Wabash River, Indiana and Illinois, for the fiscal year ending June 30, 1887:

IMPROVEMENTS BELOW VINCENNES.

The object aimed at in the improvement of the Wabash River has been to obtain a least depth of 3½ feet in the channel at low water. The project adopted for obtaining this depth contemplates the building of dikes in wide reaches of river, cutting of chutes through chain of rocks, the closing by dams or otherwise of harmful cut-offs, obtaining slack water navigation by means of a lock and dam, and removal of snags from the channel. The object of the improvement has been partially obtained. Owing to the large extent of river to be improved and to the smallness and uncertainty of appropriations it has not been possible to carry on the improvements in a systematic and continuous manner, beginning from the mouth of the river up-stream, but it has been thought best to begin improvements at those points where their need was most urgent and where works of improvement would most likely be followed by positive results.

It was in pursuance of this policy that cuts through chains of rock both at Grand Chain and Coffee Island, although separated by a great length of river, with many bad places intervening, were begun and completed first. The next improvements were also made in the order of their respective importance, continuing with the dams at New Harmony Cut-off, Turkey Island Chute, dikes at Winkler's Bar, McIntyre Bar, and lastly at Little Chain.

Snagging was also carried on for several years with great benefit to navigation, until the failure or smallness of appropriations caused the boats to be laid up. No snagging has been done for four years.

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In addition to those points where improvements have been carried on, the greatest obstruction to through navigation has been a chain of rock shoals known as Grand Rapids, which can not be passed by steam-boats except at a high stage of water.

This obstruction has practically cut the navigation of the river in two.

A lock and dam, built many years ago by the Wabash Navigation Company at this place, served for many years as a means of communication between the upper and lower parts of the river, but unfortunately, owing to defective construction and want of repairs, the dam has been carried away, the lock-walls have fallen in, and the whole work has become a total wreck.

It has always been the intention of the various officers in charge of this improvement to reconstruct the lock and dam at Grand Rapids as soon as a sufficient available sum of money would warrant the beginning of the work.

An appropriation of $30,000 having been made for this work on June 30, 1885, a contract was entered into for furnishing a portion of the stone for lock, and stone has been received from time to time.

A new appropriation was made August 5, 1886, appropriating $51,000 for continuing lock at Grand Rapids and for improving the river from Grand Rapids to its mouth. An additional appropriation of $9,000 was also made to be expended in preventing cut-off at Grayville, and the following project of expenditure for the fiscal year 1886–'87, was adopted.

Lock at Grand Rapids, getting additional stone and laying foundation courses.	$36,000
Repairs of barges, snag-boats, and snagging	10,000
Reserve fund for contingencies, care of plant, etc	5,000
Building levee at Grayville	9,000
Total	60,000

CONDITION OF THE RIVER.

Owing to want of sufficient appropriations in previous years no repairs have been made to existing works, and the condition of river is not as good as in former years.

The principal obstructions are as follows:

Skidmore Bar, 2½ miles from mouth.—No work has been done on this bar.

Widow Goss's Bar, 19 miles above mouth of river.—No work done yet at this point. Works of contraction should be constructed to reduce width of river.

Little Chain.—This obstruction is 25 miles from mouth of river, and consists of a chain of rocks 2,000 feet long, through which a channel 50 feet wide has been blasted, but which has only been dredged to a width of 35 feet. This improvement as far as completed has been successful, but owing to want of funds has not been completed to the full width of 100 feet, as intended. During the past year a good deal of the stone with which the dikes had been paved, and also a portion of the rock blasted but not dredged out, has rolled in the chute and carried by the force of the current to the foot of it, thus obstructing a channel already too narrow, and making the passage of steamboats difficult and dangerous.

This improvement should be completed, or at least that portion of it which has been blasted should be removed with the dredge, and the dikes built of low cribs filled with stone instead of the former plan of paved dikes, which experience has demonstrated to be unsatisfactory. A cross-dam composed of piling, which has been built across the Little Chain Cut-off, in order to prevent waste of water from main river, has been flanked around the right abutment by the river, which has cut for itself a channel about 90 feet wide, and a large volume of water is thus allowed to escape.

A new dam, consisting of cribs, but little above low water should be built at head of cut-off.

Marshalls' Ferry, 29½ miles from mouth.—A few large bowlders in the channel ought to be removed.

Grand Chain, 31 miles from mouth.—No work done during last season.

This obstruction, which until cut through presented, at low water, an impassable barrier to navigation, is, for want of repairs, lapsing into an unsatisfactory condition. The ice and drift carried during high water have greatly injured the paving on the left dike at head of chute, while the greater portion of stone of which right dike was composed has been washed in the chute, thereby shoaling and narrowing it and rendering the improvement of much less value than formerly.

The head of chute should be deepened at least 2 feet in order to obtain a depth of not less than 4 feet at low water from one end to the other. The right dike should be lined with a row of low cribs previous to dredging, the cribs to be filled with stone set edgeways, to avoid further washing out. The location of chute has never been all that could be desired; nevertheless the improvement has been successful, and, with a few yearly repairs, is permanent.

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Warwick's Ripple, 39 miles from mouth.—The rocks in the channel were removed several years ago, the improvement having been quite successful. A few more stone should be removed at a small expense.

Dam at New Harmony, about 50 miles from mouth.—The new cut-off around end of dam, which was mentioned in last year's report, has further increased in depth and width, and it is estimated that fully one-half of the discharge of the river passes through it. The present dimensions of cut-off are 325 feet in width, with a depth of 12 to 15 feet, some soundings showing as high as 17 feet, with rock bottom.

The effect of this drain on the main river has been to lower the upper pool, ½ mile above it, some 8 inches, and to cause the main river to become shallower every year, so that at low water it is impossible for boats to come up around the island, and navigation from the mouth is suspended at foot of cut-off. Neither can the boats ascend or descend through the cut-off, except at high water, as there is a fall from head of cut-off to foot of same of about 7 feet in 2 miles, most of which fall, or 4½ feet of which, occurs in a very short distance over a natural rock dam once used as a mill-dam, and located some ½ mile above foot of cut-off.

Our various improvements around the island, which had been quite successful, have thus become useless, and a very rich section of river 12 miles in length is thus directly deprived of navigation, while indirectly the whole lower river suffers from the want of through navigation, as the boats in the lower Wabash leave the river as soon as water is getting low.

The new cut-off should be closed, either with a low dam supplemented with a levee across Ribeyres' Island or by any other means which a thorough survey of the existing conditions would indicate as most suitable. The main difficulty, however, in any work of improvement will be the securing of the end of the dam to the island in such a manner that the river will not cut around it.

Grayville Bend Cut-off, 62 miles above mouth.—This threatened cut-off, which if neglected another season would undoubtedly have been beyond mending, has been closed during last fiscal year by a levee 4,330 feet long, with its top 3 feet above high-water mark of 1875. This work, although not quite completed during the present fiscal year, has been very successful, and there is no apprehenson of the cut-off forming again unless the levee should again be tramped and broken down by travel of stock and vehicles during high water. In order to reduce the danger from this cause to the minimum a barb-wire fence has been built all around the levee. The levee has been sown with grass seed, young trees have been planted in the cut-off at foot of levee, and it is believed that the improvement is permanent as long as the river does not cut in the main river bank so as to undermine the levee. A work of this kind should, however, have at all times a contingent sum at its credit, in order that any slight repairs needed may be made at once, at the least expense and before any serious damage has been done. I append a few data in regard to this work:

Length of old and new levee raised, repaired, and built during fiscal year ending June 30, 1887.....feet..	4,225
Number of cubic yards of material put in levee.....	41,700
Money expended to June 30, 1887, from all causes.....	$7,772.69
Cost per cubic yard put in the levee.....	$0.1863

The work was done with teams and scrapers, the teams being paid 25 cents per hour and laborers 15 cents per hour. The levee was built with a slope of 1 to 3 and a width on top of 8 feet.

Coffee Island Chute, 85 miles from mouth.—No work has been done since 1873. Repairs are needed both at head and foot of chute. It is intended during the present fiscal year to remove some of the snags and a few of the largest stones at foot of chute with the snag-boat.

White River Shoals, 91 miles above mouth.—This shoal consists of a ledge of rock, about 2,200 feet long and extending clear across the river; at very low water this presents an impassable obstruction to steamboats going up the Wabash or White rivers. No work has been done here. Should an improvement of this shoal be attempted the work ought to be thorough, and for this reason it is proposed to cut a channel through the rock 100 feet wide, 4 feet deep, and 2,200 feet long.

Lock and dam at Grand Rapids, 92½ miles above the mouth.—As mentioned in the earlier part of this report, the amount which it was intended to expend during this fiscal year was $36,000, this to be applied to the purchase of additional stone and laying of the first courses of masonry. In addition to this it was expected that the contractors for stone would furnish all the lower courses for the lock; only a small quantity of the stone contracted for has been received, although the time for completion of contract, after being extended to September 1, 1886, then to January 1, 1887, was extended once more to July 1, 1887. No stone was received from them between January 1 and July 1, 1887, the dates of their last extension. The total quantities of stone received last year were as follows: 366,308 cubic yards, for which the sum of

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$3,446.29 was paid. There being on hand a sufficient quantity of stone to begin the laying of masonry of lock, the work of excavation of the old lock was begun on April 1, 1887, and continued without interruption to June 30. The progress of work has been quite decided, the land wall having been entirely excavated for its whole length and for a width of 15 feet, while up to June 30 the river wall was nearly all taken out for a width of 17 feet. Three sides of coffer-dam have also been built up to a height from 15 to 18 feet above low water, and it is expected to begin the laying of masonry in a short time. The work of excavation has been more laborious than anticipated when first estimate for lock was made, as during the 15 years that the lock has been in disuse the lock chamber has become filled with mud, sand, and débris of all sorts to a depth of 15 feet, the total number of yards excavated to June 30, 1887, being nearly 14,000, and the amount paid for excavations and purchase of plant to same date has been $7,734.76.

During the fiscal year our fleet of steamboats and barges, which for want of appropriations had been idle for several years, was found to be in such a state of dilapidation that repairs became necessary at once. Our snag-scow for the upper Wabash being the worst, it was decided to remove the machinery to another comparatively new barge; this was done last fall, the new scow being completely made over and being now in first-class order.

One barge was also repaired very extensively, and our towboat, the *Osseo*, was also put on the ways, straightened, repaired, and painted. The sum expended for these repairs is $1,486.11. The snagboat *Richard Ford*, which had not been in commission for four years and had been carried away by the ice in the winter of 1885–'86, was in such a dilapidated condition that repairs were not undertaken until the spring. The repairs on this boat are now almost completed, and it is expected to put her in commission as soon as the stage of water allows.

During the four years which have elapsed since the snagboat was in commission numerous new snags have been deposited, many of which are dangerous to navigation. It is intended to remove them during the present fiscal year.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Major AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS,

Showing the amount of freight carried on the Wabash River, below Vincennes, during the fiscal year 1886–'87.

Corn	bushels..	491,800
Wheat	do....	178,000
Lumber	feet, B. M..	50,000
Staves and heading	bunches..	4,500
Staves		72,000
Hickory butts	cords..	475
Stave blocks	do....	360
Railroad ties		20,000
Saw-logs rafted and sawed by the saw-mills along the river	feet, B. M..	15,778,056

Lists of steam-boats plying on Wabash River, below Vincennes, during the fiscal year 1886–'87.

Names.	Where plying.
D. A. Goodin	Vincennes to Mount Carmel.
Montezuma	Do.
Jumbo (floating saw-mill)	Do.
Kid (floating saw-mill)	Do.
A. Carey	White River to mouth of Wabash River.
John R. Hugo	Mount Carmel to mouth of Wabash River.
Experiment	White River to mouth of Wabash River.

Besides these boats the following Ohio River boats have made trips at various times: *City of Nashville, B. S. Rhey, Minnie, T. Shiver, John Gilbert, Girty Pool.*

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IMPROVEMENTS ABOVE VINCENNES.

The small amount of money available for work on this part of the river made it impracticable to accomplish much.

The snagging outfit was put in good repair and set to work cleaning out the cut-off at Horseshoe Bend. A pile and brush dam had been placed across the cut-off some years ago, with the hope of stopping the flow through the cut-off The water cut around the dam and re-established the cut-off, and the river around Horseshoe Bend shoaled up; this, with the dam, formed a complete barrier to navigation past this point at low water. As the cut-off did not decrease the length of river to any serious extent, and it seemed doubtful as to rebuilding the dam and making it secure at a reasonable cost, it was decided to open a passage for navigation, and remove as many snags and other obstructions as possible. This was done, though not as thoroughly as desired, when work ceased on account of exhaustion of funds.

ESTIMATES.

The following table of estimates is for the more important work needed in this part of the river, and any funds that might become available would be applied to the objects stated:

Snagging five months (yearly), at $800 per month	$4,000
Repairs to Eight-mile Dam	500
Dredging	4,000
Contraction works and bank protection	10,000
Care of plant and contingencies	1,500
Total	20,000

The report of Assistant Engineer O. L. Petitdidier is appended.

Money statement.

July 1, 1886, amount available		$2,103.71
July 1, 1887, amount expended during fiscal year exclusive of liabilities outstanding July 1, 1886	$2,018.91	
July 1, 1887, outstanding liabilities	14.72	
		2,033.63
July 1, 1887, amount available		70.08
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. C. L. PETITDIDIER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 25, 1887.

MAJOR: I have the honor to submit the following report on improvement of Wabash River, Indiana and Illinois.

IMPROVEMENTS ABOVE VINCENNES.

The portion of river above Vincennes upon which improvements have been made is 90 miles in length. The works of improvement have consisted in the removal of snags, and the construction of two dams across hurtful channels.

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The removal of snags in 1883 and 1884 gave a new impetus to the low-water navigation, which had heretofore been almost entirely suspended; unfortunately the want of appropriations for several years has interfered with this work, and many new snags have again lodged in the narrow or difficult portions of the river.

Owing to the presence of snags, the steamboat men complain that navigation at low water has to be stopped fully one month sooner than the depth of water in the channel would otherwise require. Of the two dams built, one at Eight-mile Island has accomplished its object, a few repairs are, however, necessary to render the improvement permanent. The dam at Horseshoe Bend, which, as mentioned in former report, was a failure, has been removed, and the river allowed to pass through its new channel.

This has been done during the present fiscal year, and the new channel has been used exclusively by the steamboats until the middle of June, 1887. Owing to the small balance of funds, however, the removal of snags, piling, brush, and stone, in the cut-off could not be made as thorough as desirable, so that there are still a few obstructions which ought to be removed; this can not be done until new appropriations become available, as the present funds are almost exhausted. The following snags were removed at Horseshoe Bend Cut-off during the present fiscal year:

Number of snags removed		37
Average length	feet	54.35
Average weight	pounds	12,885.8
Total weight	do	476,775
Number of trees cut on banks and disposed of		65
Number of piles removed		65

In addition to this work the towboat *Osseo* and snag-scow were thoroughly repaired.

The principal work needed on this portion of the river at present consists of the yearly removal of snags, dredging of several gravel-bars, and works of contraction at various points. No work can be done this year unless money be appropriated.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. Army.

COMMERCIAL STATISTICS.

The commerce of this portion of the river is considerable and increasing steadily, there being six steam-boats regularly plying between Vincennes and Terre Haute, Ind.

AMOUNT OF FREIGHT CARRIED ON WABASH RIVER ABOVE VINCENNES DURING THE FISCAL YEAR 1886–'87.

Corn	bushels	699,224
Wheat	do	118,488
Flour	barrels	2,000
Salt	do	500
Coal	tons	397
Lumber	feet, B. M.	1,360,725
Merchandise	tons	838
Passengers	number	2,000
Skiffs for lumbermen returning home	do	300
Staves and heading	bundles	18,639
Brick	number	55,000
Fruit trees	do	1,865
Hogs	do	375
Horses	do	35
Stone	cubic yards	7,334
Saw-logs, rafted and sawed by the mills along the river	feet, B. M.	9,300,000

The following is a list of steamboats plying on Wabash River, between Vincennes and Terre Haute, during the fiscal year 1886–'87: *Rosedale, Ida Lee, Cohassett, Crown Point, Diana, Dauntless.*

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D. D. 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The work on White River during the year has been confined to repairs of plant and dredging rock from the cut which had previously been blasted at Kelly's Ripple. The dredging was confined to one month in the fall, as during the spring, when the water was at proper stage, the dredge was urgently needed at the lock-site at Grand Rapids on the Wabash River. The work will be resumed as soon as the dredge can get up to Kelly's Ripple, the water being now too low, and it is proposed to limit the width of cut to 75 feet. Advertisements have been published calling for proposals for a new hull for the dredge, to be opened in August. During the year 2,625 cubic yards of rock were removed from the cut, giving an added width of from 12 to 15 feet for over half the length of the cut. The Hazelton Bridge still continues to be an obstruction to the navigation of the river.

The following estimate is presented for needed work, and it is proposed to apply any funds that might be available to the objects mentioned.

Completing cut at Kelly's Ripple	$8,000
One year's snagging	4,000
Dredging	4,000
Care of plant and contingencies	1,500
	17,500

The report of Assistant Engineer O. L. Petitdidier is appended.

Money statement.

July 1, 1886, amount available	$404.81
Amount appropriated by act approved August 5, 1886	7,500.00
	7,904.81
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,964.32
July 1, 1887, amount available	4,940.49
Amount (estimated) required for completion of existing project	17,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	17,500.00
Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. O. L. PETITDIDIER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 25, 1887.

MAJOR: I have the honor to make the following report on improvement of White River, Indiana, for the fiscal year ending June 30, 1887. An additional appropriation of $7,500 was made for this work on August 5, 1886.

In continuation of the project of improvement adopted the work of excavation at Kelly's Ripple was resumed with the dredge on October 21, 1886, and carried on until interrupted by high water November 20, 1886.

CONDITION OF THE RIVER.

With the exception of snags which form now the worst obstruction, the river from its mouth to Hazelton is in a fair condition. The work of improvement at Kelly's Ripple, where the worst obstruction occurred, though not yet completed, allows steam-

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boats to pass over this whenever the stage of water is such as to allow steamboats to get to the chute. This chute which has been cut through the rock for a length of 2,050 feet and a depth of 4 feet, has been increased in width from 12 to 15 feet during last fiscal year for over half its length. It is proposed to keep on widening the chute until a clear width of 75 feet is obtained.

The work done at Kelly's Ripple during the last fiscal year is as follows:

Linear feet of cut dredged (12 to 15 feet wide)	feet..	1,090
Cubic yards of rock removed		2,625
Average daily progress	linear feet..	42
Cubic yards removed per day		101
Number of days worked with dredge		26

It is proposed to continue the improvement at Kelly's Ripple until completed. The hull of the dredge which has been used on both Wabash and White rivers for several years, being now almost beyond repair, it is proposed during the present fiscal year to build a new hull for it, to which it is intended to remove the machinery, the expense to be borne equally by Wabash and White rivers.

Very respectfully, your obedient servant,

O. L. PETITDIDIER,
Assistant Engineer.

Maj. AMOS STICKNEY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of steam-boats plying or which have made various trips on White River during the fiscal year 1886–'87.

Names.	Where plying.
Experiment	Pittsburgh to mouth of White River.
D. A. Goodin	Hazelton to mouth of White River.
A. Carey	Hazelton to mouth of White River.

Statistics showing the amount of freight carried on White River during the fiscal year 1886–'87.

Designation of freight.	Quantities.
Corn, bushels..	60,000
Wheat, do ...	5,000
Logs towed by steamboats, feet, B. M..	1,500,000
Logs handled by saw-mills and which have been received by the water route, do....	15,100,000

D D 6.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

This work was in charge of Maj. James C. Post, Corps of Engineers, until May 6, 1887, when it was transferred temporarily to my charge.

The Kentucky River is a tributary of the Ohio, emptying into it at Carrollton, Ky., about midway between Cincinnati, Ohio, and Louisville, Ky.

The present project for the improvement of this river was adopted in 1879, the object being to repair the five locks and dams built by the State of Kentucky, and extend slackwater navigation for a draught of

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6 feet, by the construction of additional locks and dams at Beattyville, a distance of 261 miles from the mouth of the river.

During previous years the five original locks have been repaired, and three of the dams rebuilt; the fourth and fifth having also been restored to a serviceable condition.

A line of levels was run from Lock No. 4 to Lock No. 1, for the establishment of the elevation of the several miter sills.

LOCK AND DAM NO. 6.

Contracts have been entered into for the stone of Lock No. 6. The contractors are now at work getting out the stone.

BEATTYVILLE DAM.

The construction of the Beattyville Dam was continued, and completed on October 30, 1886. The gates worked perfectly at all stages of the water, and demonstrated the fact that the gates in both passes could be worked perfectly by the one culvert in the middle wall, and that no further power was necessary, the pool raising the gates as it rose.

The velocity of the water through the passes was very great, reaching 13.5 miles per hour, at a stage of 20 feet. At the lower end of the passes, where the swift water from the chutes meets the still water of the pool below, and the reacting water from the dam at higher stages, a short chopping sea is formed which is quite dangerous to coal-boats and rafts. A large number of injuries to rafts was due to careless rafting, and to their crews not being accustomed to such navigation. The crews would often desert the rafts before they reach the mouth of the passes, allowing the rafts to come in broadside.

Shortly after the passes were opened for navigation a pressure was noticed under the floor, and the sheeting commenced to rise in the lower portion of the floor beyond the foot of the slope. Holes were then bored in the floor so as to allow this water causing the under pressure to escape. Work was then commenced to stop the leakage from above, by driving sheet-piling, but high water prevented a continuance of this work, and the chutes were left to their fate. The floor of the lower end of both passes was raised by pressure upwards, the water then attacked the gravel above the crib at the lower end of the chute, and the crib was soon torn out. The reaction of the water continued tearing up the floor and undermining side walls, until a portion of the latter fell over, and the floor was removed nearly up to the gate recesses. This, notwithstanding the fact that the floor was securely spiked to 12-inch oak caps, which were fastened to piles driven into the bottom as far as practicable. In some instances the caps were split, and in others the bolts securing them to the piles were drawn through them; and in others, the floor, caps, and piles were all lifted together.

The condition of the work was finally such, that, before undertaking to make repairs, the subject was referred to the Board of Engineers, which had previously discussed this subject, and had recommended the plans on which the work was originally constructed. The Board, after carefully investigating the subject and visiting several localities where chutes were used for the passage of rafts and crafts from one pool to another, finally decided, from the experience already gained at Beattyville and the difficulties that are encountered elsewhere in the use of

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chutes, that the interests of navigation at Beattyville would be best served by substituting a rapid-acting lock for the chutes, as they believed that coal-boats of the type used on the upper Kentucky could not run chutes in safety. This recommendation of the Board was approved by the Chief of Engineers and Secretary of War. Plans will therefore be matured as rapidly as possible for the construction of the lock.

It is not improbable that some work will be necessary, in order to prevent the destruction of the dam, before the lock can be commenced.

UPPER KENTUCKY RIVER.

A meander line of the river was run from Old Landing to Beattyville, a distance of 20 miles. No work has been done during the past year on the shoals on that portion of the river between the crossing of the Kentucky Central Railway and Beattyville since the work was suspended, October 12, 1885, with the exception of the removal of snags.

SNAGBOAT KENTUCKY.

The name of the snag-boat was changed from *Kwasind* to *Kentucky*. The rebuilding of this snagboat was completed October 1, 1886.

From May 26 to June 19 the *Kentucky* was laid up at Lock No. 1, her crew operating the lock and making the following repairs:

Painting the entire boat inside and out; new bed-plates to capstan were placed; exhaust pipes were placed in stern of boat; braces were placed under ridge-pole, supporting cabin and boilers; frames made for pumps. The wheel was cut down 5 inches, and hold thoroughly cleaned; machinery thoroughly overhauled and cleaned.

Work done during year ending June 30, 1887:

Obstructions removed	number..	802
Miles run	do....	1,840
Working at Lock No. 4	days..	36
Working at Lock No. 1	do....	5
Laid up in winter quarters	do....	82

It is recommended to continue the work of straightening and widening the passes through the shoals, and the removal of snags and overhanging trees.

Two steamboats and several freight boats run on this portion of the river. The roads through the mountains become impassable during the winter and spring, and the only outlet and means of obtaining supplies for this region is by means of the Kentucky River. The recommendation contained in Maj. James C. Post's last annual report, that Congress authorize, without delay, the purchase of the lands for the additional locks and dams necessary to complete the improvement of the river, is renewed.

Attention is invited to the fact that it has taken two years to obtain the land for Lock and Dam No. 6. It is probable that an equal length of time will be required for a similar purpose at each of the ten remaining locks to be built.

It is proposed to continue the work of improvement by completing Lock and Dam No. 6, lock at Beattyville, and the construction of additional locks and dams with the amount asked for.

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Money statement.

July 1, 1886, amount available		$84,598.14
Amount appropriated by act approved August 5, 1886		187,500.00
		272,098.14
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$113,271.76	
July 1, 1887, outstanding liabilities	459,01	
		113,730.77
July 1, 1887, amount available		158,367.87
Amount (estimated) required for completion of existing project		2,034,139.26
Amount that can be profitably expended in fiscal year ending June 30, 1889		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received by Maj. James C. Post, Corps of Engineers, during the fiscal year ending June 30, 1887, for furnishing stone for Lock No. 6, Kentucky River, Kentucky.

	1. James Keigwin.	2. O'Brien & Co.	3. Thos. P. Shanks.	4. I. V. Hoag, jr.	Approximate quantity required.
Cut stone:	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Cu. yds.*
Dressed face	$9.50	$10.75	$11.50	$14.00	1,700
Quarry face	8.50	9.00	10.50	12.00	1,487
Squared stone	7.00	6.50	7.50	7.50	1,360
Backing stone	5.50	5.50	6.00	6.00	6,108
Special stone	18.00	17.60	20.00	20.00	252
Coping	17.00	16.50	20.00	20.00	376
Aggregate	82,831.50	84,731.20	94,571.50	101,062.00	.....

Bids were opened May 2, 1887. The contract was awarded to O'Brien & Co. The bid of James Keigwin was rejected for cause.

ABSTRACT OF CONTRACTS—O'BRIEN & CO., DATED JUNE 9, 1887.

Purpose and consideration.

That the party of the second part shall furnish and deliver to the party of the first part the stone required for the construction of a lock in Kentucky River, near the head of the present slackwater navigation on said river, about 1 mile below the village of Oregon, and 32 miles above the city of Frankfort, Ky., observing and fulfilling each and every requirement and stipulation of the specifications aforesaid, and of their proposal dated Cincinnati, Ohio, May 2, 1887.

That the party of the first part shall pay to the party of the second part for each and every cubic yard of stone so delivered the following rates, viz: For cut stone, dressed face, $10.75; for cut stone, quarry face, $9; for squared stone, $6.50; for backing stone, $5.50; for special stone, $17.60; for coping, $16.50.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., July 18, 1887.

LIEUTENANT: I respectfully submit the following report for the fiscal year ending June 30, 1887, upon the construction of the movable dam at Beattyville. The construction work was continued and completed in accordance with the plans, October

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30, 1886, with the exception of the completion of additional pile sheeting around the faces of the guide-walls above the gate recess and at the breast of the recesses. This work was suspended in November on account of high water. Modifications were made in various parts of the work as the construction progressed as follows: An additional step was constructed to the dam; the abutment was extended an additional distance below the dam 100 feet 9 inches, with return-wing to solid rock of 76 feet; a return-wing above into the bank 75 feet in length was added, as well as one extending straight back on the line of dam 55 feet 6 inches in length; the sill of the passes was lowered from 2 feet above low water to 6 inches above.

The floor to the passes was constructed the entire length of the chute in place of one-third the distance as was originally designed. During the past season of freshets the earth filling behind the abutment settled, as was expected, and additional backing was placed where settlement occurred. A drain was constructed along the upper line of the United States property to lead the water below the work. A large slip occurred below the abutment, caused partially from the reacting water from the dam and principally from seepage from the coal mines on the bluff above. The exceptionally heavy rains caused an unprecedented amount of caving and slipping of the banks the entire length of the river. The Proctor Bank below the passes washed considerably. At the first opportunity riprap stone was placed on the foot of this bank, which checked the washing. A bar formed below the passes from materials washed from underneath the floors. This bar divided the water at low stages, throwing it in the direction of both banks.

The reacting water from the dam, running up the chute, meeting the swift water flowing through them, together with accumulated leakage from all directions through the face sheeting to the guide-walls, raised the floors. The pressure was so great that piles driven from 16 to 20 feet were pulled up with portions of the floor. After pieces of the floor were washed out the scour around the lower end of the guide-walls undermined them, causing them to careen and settle. The waves produced at the sole of the passes by a meeting of the water were found to be exceedingly dangerous to crafts of all kinds. Many rafts were broken up by these waves. Those poorly constructed would dive at this point and before recovering their horizontal position would strike the bar and be broken up. Rafts well constructed generally passed in safety. Boats, barges, and other crafts could not safely run the chutes either in ascending or descending. The construction was attended by several difficulties.

The season being an unusual one for heavy rains and freshets, the location being at the three forks of the river, made the rises both sudden, and, in comparison to the rain-fall, very high. The coffer-dam, aggregating about 1,800 linear feet in length, was flooded on an average of once a week until within three weeks of its completion. Quicksand was found in excavating for a portion of the foundation of the abutment, which more than doubled the quantity of excavation for this portion of the work. Skilled labor was scarce, and difficult to hold, on account of the unhealthy condition of the surrounding country; fully one-half the working force was more or less ill at a time. Material required could only be obtained by hauling it a distance of 45 miles over mountain roads nearly impassable. The construction was continued night and day until its completion. The construction of this dam has had a very beneficial effect on the section of country surrounding it. Capital has been directed toward it; syndicates have purchased large tracts of mineral land bordering on the pool, proposing to develop the same, and three different lines of railroads are now being surveyed with a view of crossing the Kentucky River at some point in the pool; and unquestionably the time is now at hand for making suitable provisions for the safe transit of crafts of all kinds, both for ascending and descending navigation.

Mr. J. W. Walker, inspector, ably and energetically seconded my efforts to complete the work in one season.

The following papers accompany this report, viz: Commercial statistics; report of lockages; statement of materials used in the construction of abutment; statement of materials used in the construction of the dam; statement of materials used in the construction of passes, gates, and guide-walls.

Very respectfully, your obedient servant,

R. S. BURNETT,
Assistant Engineer.

Second Lieut. WILLIAM L. SIBERT,
Corps of Engineers, U. S. A.

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COMMERCIAL STATISTICS.

Beattyville Dam and vicinity for fiscal year ending June 30, 1887.

Articles.	Quantity.	Average price.	Value.
Barrels ..... number..	65	$1 each	$65.00
Beer ..... cases..	276	$2 per case	552.00
Coal ..... bushels..	47,800	11 cents per bushel	5,258.00
Country produce	.....	.....	1,222.00
Cross-ties ..... number..	265,000	40 cents each	106,000.00
Cedar posts ..... do....	3,500	20 cents each	700.00
Flour ..... barrels..	2,365	$6 per barrel	14,190.00
Grain ..... bushels..	8,053	70 cents per bushel	5,637.10
Hay ..... tons..	550	$14 per ton	7,700.00
Hogs ..... head..	259	$8 per head	2,072.00
Horses ..... do....	15	$100 per head	1,500.00
Hides ..... number..	1,670	$4 each	6,680.00
Iron manufactured ..... tons..	67	$50 per ton	3,350.00
Lumber, white oak ..... feet, B. M..	324,194	$16.50 per thousand	5,349.20
Lumber, white pine ..... do....	8,750	$30 per thousand	262.50
Logs, poplar ..... number..	76,653	$3 each	229,959.00
Logs, oak ..... do....	42,780	$3 each	128,340.00
Logs, walnut ..... do....	24,750	$10 each	247,500.00
Roots ..... pounds..	450	$5 per pound	2,250.00
Salt ..... barrels..	930	$2 per barrel	1,860.00
Sheep ..... head..	175	$3.50 per head	612.50
Stone ..... cubic yards..	18,953	$1.10 per cubic yard	20,848.30
Spikes ..... pounds..	16,685	3 cents per pound	500.55
Sundries	.....	.....	1,200.00
Staves ..... number..	160,000	$40 per thousand	6,400.00
Shingles ..... do....	175,000	$3 per thousand	525.00
Timber ..... feet linear..	24,829	12½ cents per linear foot ...	3,103.62
Tobacco ..... hogshead..	67	$100 per hogshead	6,700.00
Wood ..... cords..	650	$4 per cord	2,600.00
Whisky ..... barrels..	33	$75 per barrel	2,475.00
Merchandise ..... tons..	471	$200 per ton	94,200.00
Passengers ..... number..	2,164	Fare, $2.50 each	5,410.00
Total	.....	.....	915,021.77

LOCK AND DAM NUMBER SIX, KENTUCKY RIVER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 21, 1887.

GENERAL: Referring to my letter of August 25, 1886, presenting a project for the expenditure of the $187,500 appropriated by river and harbor act of August 5, 1886, I have to submit plans and estimate for the construction of Lock and Dam No. 6, Kentucky River, for approval.

It is proposed to place this work upon what is known as Finn's Ripple, about 14½ miles above Lock and Dam No. 5, where land has already been purchased as a site. The position of the work is shown upon Sheet No. 1 of the accompanying drawings.

The lock is to be of stone and will be practically the same in all its details as that recently constructed upon the Big Sandy, with the exception that it is proposed to place pipes in the walls, that will enable the water-power stored by the dam to be used in operating the gates.

The dam is to be of timber of the same form as No. 5, recently constructed.

It is proposed to purchase the materials for the work, as far as practicable, by contract, and perform the work by days' labor. It is believed that better and cheaper work can be obtained in this manner, particularly where the amount of money available is not sufficient to complete the work.

Sheets Nos. 2 and 3 of the tracings give plans and sections of the lock, dam, and abutment, as it is proposed to construct them.

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The following is an estimate of the cost of the work:

LOCK.

Coffer-dam and excavation of foundation	$11,041.96
Masonry, 11,680 cubic yards (labor and cement included)	104,455.00
Concrete, 1,200 cubic yards, for floor of lock	5,915.00
Gates, 2 upper and 2 lower, and 4 wickets	7,902.52
Machinery for operating gates and wickets	2,224.00
	131,538.48
Engineering and contingencies, 10 per cent	13,153.85
	144,692.33

DAM.

Excavation, 10,000 cubic yards, at 40 cents	$4,000.00
Piling, 4,500 linear feet, at 35 cents	1,575.00
Timber, 100,300 linear feet, at 20 cents	20,060.00
Lumber, 278,000 feet, B. M., at $25 per M	6,950.00
Stone filling, 17,500 cubic yards, at $1	17,500.00
Drift-bolts and spike, 83,000 pounds, at 5 cents	4,150.00
Backing, 4,000 cubic yards, at 50 cents	2,000.00
	56,235.00
Engineering and contingencies, 10 per cent	5,623.50
	61,858.50

ABUTMENT.

Excavation of foundation, 2,300 cubic yards, at 30 cents	$690.00
Piling, 1,500 linear feet, at 35 cents	525.00
Lumber, 26,810 feet, B. M., at $25 per M	670.25
Drift-bolts, 1,300 pounds, at 5 cents	65.00
Masonry, 954 cubic yards, at $8	7,632.00
	9,582.25
Engineering and contingencies, 10 per cent	958.22
	10,540.47

RECAPITULATION.

Lock	$144,692.33
Dam	61,858.50
Abutment	10,540.47
Land for site of lock	1,713.79
Keeper's dwelling	2,500.00
Construction of road and fences	1,750.00
Total cost	223,055.09

With the balance of the $187,000 remaining it is proposed to purchase the stone for the lock by contract and commence its construction.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Brig.-Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 29, 1887.

Respectfully submitted to the Secretary of War.

Under authority of the river and harbor act of July 5, 1884, a title for the land required for this lock and dam has been obtained for the United

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States, and it is proposed to commence the work of construction, the total cost being estimated at $223,055.

This being the first of the series of new locks and dams which the project of improvement adopted in 1879 contemplates for the extension of the slackwater improvement of the river as far as Beattyville, 261 miles above the mouth, with the view of securing the most suitable and economical plans for this, as well as to serve as a guide in the construction of those subsequently to be built, it is recommended that the within plan be referred for examination and report to a Board of Engineer Officers, composed of Lieut. Col. O. M. Poe, Lieut. Col. William E. Merrill, and Major Amos Stickney, Corps of Engineers, with Lieut. L. H. Beach, Corps of Engineers, as recorder, to be convened by orders from this office, and directed to meet, on the call of the presiding officer, at Cincinnati, with authority to visit the locality.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
February 7, 1887.

The recommendation of the Chief of Engineers is approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 19, 1887.

Respectfully returned to the Secretary of War, submitting herewith the report of the Board of Engineer Officers constituted in compliance with the foregoing indorsement.

The plans for the proposed new Lock and Dam No. 6, on the Kentucky River, submitted by Major Post, having been, as will be seen, approved by the Board, are concurred in by this office, and being new work, it is recommended that with your sanction Major Post be directed to proceed with their construction, in accordance therewith.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Fourth indorsement.]

WAR DEPARTMENT,
March 24, 1887.

The recommendation of the Chief of Engineers is approved.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

FRANKFORT, KY., *March* 9, 1887.

GENERAL: The Board of Engineer Officers constituted by special orders No. 23, headquarters Corps of Engineers, Washington, D. C.,

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February 10, 1887, to examine and report upon the project for Lock and Dam No. 6, Kentucky River, submitted by Maj. James C. Post, Corps of Engineers, have the honor to make the following report:

The Board met on the call of the senior member at Cincinnati, Ohio, at 10 a. m., March 8, 1887. Maj. J. C. Post, Corps of Engineers, was present and the plans of the proposed lock, dam, and abutment were examined. After a consideration of the plans, the Board decided to visit the proposed site of the work and proceeded the same day to Frankfort, Ky.

On March 9, the Board, accompanied by Major Post, took passage on a steamboat provided by him, at Frankfort, and passed up the Kentucky River through Lock No. 5 to the proposed site for Lock No. 6, at Finn's Ripple, 1 mile below the town of Oregon, at which point they made an examination the same day.

After a careful consideration of the subject, the Board would respectfully recommend the adoption of the plans for lock, dam, and abutment, and of the method of construction as proposed by Major Post, and also the adoption of the location selected by him. The estimates appear to have been well considered, and, in the opinion of the Board, are sufficient. The Board see no reason for recommending any modification of the plans, and consider the site an advantageous one for the projected work.

It is proposed to make the lock larger than those now constructed, about 10 feet longer and 14 feet wider, the length between hollow quoins being 185 feet and the width between chamber-walls 52 feet.

The increase of length is simply to provide for the increased size of gates, the available length for vessels remaining the same as in the old locks.

The increase of width from 38 to 52 feet is intended to provide for the lockage of two coal barges of 25 feet beam at one time, and this increase of size the Board deem judicious on account of the probable future commerce of the river and the slight increase of cost in thus widening the lock.

While it is true that there are now five locks of the smaller dimensions on the river below the proposed new lock, it is not deemed proper to limit the capacity and usefulness of the locks yet to be constructed, twelve in number, by building them of a size which was deemed sufficient more than forty years ago, especially as the increase of cost is very little and the increase of capacity is about double.

The Board would recommend that the engineer officer in charge be authorized to use his own discretion in making such minor changes in the details of construction of the work as he may find necessary or advisable during its prosecution.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Bt. Brig. Gen'l, U. S. A.
WM. E. MERRILL,
Lieut. Col. of Engineers.
AMOS STICKNEY,
Maj. of Engineers, U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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DAM AT BEATTYVILLE, KENTUCKY RIVER.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 7, 1887.

SIR: I have the honor to submit herewith the report of the Board of Engineer officers, reconvened upon recommendation of this office of March 30 last, to consider and report upon the subject of the repairs or modifications required for remedying the difficulties experienced during the past winter in passing boats and rafts through the chutes of the movable dam at Beattyville, Kentucky River.

The construction of a lock and movable dam at this place was provided for by the river and harbor act of August 2, 1882, before any report of the usual preliminary examination or survey, or any recommendation from this office therefor, had been submitted to Congress. The work presented so many difficulties that it was referred to a Board of Engineer officers to report the kind of structure deemed most suitable to carry out the instructions of Congress, and the plan adopted, of a fixed timber dam, with chutes controlled by bear-trap gates, although considered at the time as experimental in a great degree, was thought would satisfy all the conditions required, and, by dispensing with a lock, materially diminish the cost.

The same Board, in this report, now concludes, after careful investigation and examination of similar structures at other places, that from the experience already gained at Beattyville chutes are not the best or proper means of satisfying the requirements of navigation at this place, and that none can be built at reasonable cost in a dam of the lift required that can be run with safety by the coal boats of the Upper Kentucky River, and therefore recommend that the repairs or modifications of the existing chutes be not undertaken; and, further, that the stone lock originally contemplated in the project adopted for the extension of slackwater navigation on this river be substituted therefor.

Concurring, from a careful consideration of this report, in the conclusions of the Board, I would recommend that no repairs be made to the chutes at Beattyville, and that no additional work be done upon them except so far as may be found necessary to prevent interruption of navigation; and that such balance of the appropriation of August 5, 1886, for continuing the improvement of Kentucky River as may remain available after providing for the new Lock No. 6 be applied towards obtaining, by contract, so far as funds will admit, the stone required for a lock to be substituted for the chutes, and that the officer in charge of this improvement be instructed accordingly.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

[First indorsement.]

WAR DEPARTMENT, *June 9, 1887.*

Approved as recommended by the Chief of Engineers.
(By order of the Secretary of War.)

JOHN M. TWEEDALE,
Chief Clerk.

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REPORT OF BOARD OF ENGINEERS.

WASHINGTON, D. C., *May* 30, 1887.

SIR: The Board of Engineers appointed by Special Orders No. 146, dated Headquarters Corps of Engineers, October 30, 1883, "to consider and report upon the application of the appropriation of August 2, 1882, for the erection of a lock and movable dam at the junction of Three Forks of Kentucky River," which was reconvened by Special Orders No. 53, dated Headquarters Corps of Engineers, April 7, 1887, would respectfully submit the following report:

The construction of a dam at Beattyville, Ky., was ordered by Congress without a preliminary examination or survey, and without recommendation from the engineer officer in charge of the improvement of the Kentucky River. The order in question is found in the act of Congress of August 2, 1882, and reads as follows:

> Improving Kentucky River, Kentucky, continuing improvement from mouth of river to Three Forks, $225,000, of which sum $75,000 shall be used for the erection of a lock and movable dam at Beattyville, at junction of Three Forks.

The question as to the use to be made of the allotment just named was referred to a Board of Engineers, of which the undersigned were members.

After visiting the locality, which is well up in the mountains, and almost inaccessible except on horseback, the Board decided that none of the ordinary types of movable dams used in foreign countries would be admissible on account of the great cost of construction and maintenance, but especially on account of the great amount of drift in the Kentucky River, and the suddenness of its floods. Beattyville is at the junction of the Three Forks, which are mountain streams flowing through a very steep country, from which the rain-fall is shed with extreme rapidity. The country is sparsely settled and is absolutely devoid of telegraphs or railroads that could bring warning of impending floods. Under these circumstances the Board decided that the only type of movable dam that could possibly be used was the kind known as the "bear-trap," of which small-sized specimens are common in the mountains of Pennsylvania. An extended trip was made to examine these "bear-traps," and particularly a very wide one then in existence in the Monongahela River near Pittsburgh. The conclusion to which the Board came was that bear-trap dams of such sizes as were needed could readily be built at Beattyville, and that they could be handled with ease and certainty, even if overtaken by a sudden flood.

Experience has shown that the Board was correct, and that bear-trap gates 60 feet in width, and having a vertical lift of 12½ feet, can be successfully handled by one man; but a serious and unexpected difficulty has arisen in another quarter. The Beattyville Dam, as recommended by the Board, was to consist of a fixed dam, with one or more openings controlled by bear-trap gates, the design being to lower these gates whenever required and permit rafts and coal barges to go through the openings thus created. It was recognized that it was necessary to build chutes for the use of navigation, but it was believed that by making these of a suitable length there would be no difficulty in passing from the pool of the dam to the open river below. In the latter matter the Board regret to have to report that their expectations have not been realized. The current through the chutes is fairly smooth at the upper end, but where the swift flow strikes the still-water of the lower pool a violent disturbance is created, giving rise to

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waves that are absolutely impassable by coal-boats, and are occasionally destructive to rafts. The reactions at the lower ends of the chutes have torn away the flooring to within a few feet of the gates, and have overthrown half of the outer wall and about one-third of the middle wall, and threaten the lower end of the land wall. These damages look badly, and some expenditure of time and money would be required to restore the chutes to their normal condition, and to strengthen them, so that such accidents would be impossible in the future. The Board are of the opinion that there is no difficulty at all in repairing the chutes so that they can withstand the effect of the rush of down-flowing water; but, in view of the formidable waves that obstructed the lower ends of the chutes, it is evident that, unless some method of reducing the waves can be devised, the chutes will still fail of their object, no matter how strong they may be made.

One of the chief reasons for building a dam at Beattyville, in advance of the gradual upward extension of the slackwater system, was to bring to market the vast stores of coal lying in the hills of the Three Forks. To handle coal successfully requires a deep pool for loading and a safe method of passing to the open river below whenever occasion requires. It is therefore evident that, unless such a safe passage can be provided, the dam will not help the coal interest, and it is well known that the rafting interest prefers an unobstructed river.

Under these circumstances the Board decided to visit the chutes on the Upper Susquehanna River, to ascertain the character of the flow through these chutes, with a view of adopting such features as might seem applicable to the Upper Kentucky. Accordingly, they visited the chutes at Lock Haven, Williamsport, and Muncie, and were kindly assisted in their examination by the resident engineer, Mr. Garrigues.

These chutes are, respectively, 28 feet, 60 feet, and 35 feet wide, and the inclination or slope through them, as shown by the surface of the water at the time of the visit, was about 1 foot in 100. Notwithstanding this flat slope, the velocity of the current was found to be about 10 miles an hour, and the waves at the lower ends of the Lock Haven and Williamsport chutes were, in the opinion of the Board, two great to permit the passage of loaded coal-boats in safety. A breach in the dam at Munsie, which lowered the upper pool, prevented the Board from seeing the chute at that place in its normal condition.

The Board were informed that the water in the Susquehanna was at its most favorable stage for running the chutes at the time they saw them, and that at higher stages the waves at their lower ends are much more formidable. It was particularly mentioned that in the highest navigable stages the waves at the foot of the Williamsport chute are so rough that even rafts can not pass through it without injury.

From the facts thus ascertained and the result of the experience already gained, the Board are fully convinced that chutes are not the best or the proper means of satisfying the requirements of navigation at Beattyville, which must accommodate coal-barges of rather weak construction, as well as rafts of timber.

The longer a chute is, within reasonable limits, the better it becomes for purposes of navigation. A sensible and advantageous retardation of the velocity of flow through the chute may also be gained by a moderate roughness given to the bottom. There should also be a due relation of the width to the location and use of the chute. Too much width is undesirable.

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But the determination of the proper arrangement of a suitable chute at Beattyville, having in view the peculiar requirements of the navigation and other conditions of that locality, would necessitate the expenditure of much time and money in what must still be deemed, to a great extent, an experimental structure, which might be subject to further modifications after additional experience.

The Board believe that a chute can not be made at reasonable cost, in a dam of the lift of the one at Beattyville, that can be run with safety by the coal-barges of the Upper Kentucky.

It is therefore recommended that the repair or modification of the chutes in the existing dam at Beattyville be not undertaken, especially as experience has shown the difficulty at reasonable cost of securing them against the violent forces of the high and sudden freshets to which they are necessarily exposed.

As a substitute the Board propose the construction of a stone lock of the size already adopted for the extension of slackwater navigation upon the Kentucky River, believing that such a structure will best serve the commercial interests of the Upper Kentucky. The fixed dam already built will preserve a constant pool for the loading of coal-boats, and the lock will insure their safe passage into the open river below. With the dimensions proposed, which will admit of the passage of two and possibly three coal-boats at a single lockage, and gates fitted with all the modern appliances for rapid handling, there will be but little delay to boats and rafts passing down-stream when the water is high enough to float them in the river below the dam.

This portion of the Kentucky River is only navigable for coalboats and rafts about six months of the year; generally from December to June. During this period there are frequent freshets and sudden, and sometimes violent, changes in the height of the water. Rafts and coal-boats can not pass down the river before it rises, and when they do start they must hasten, in order to pass over the 160 miles of unimproved navigation before the water falls; if they fail, they can not reach a market without delay and additional expense. For this reason the Board attach particular importance to having the proposed lock supplied with power for operating the gates quickly and for pulling rafts and boats into and out of the lock-chamber.

The Board have not the data at hand to calculate the guard that should be given to this lock, but they wish to call special attention to the fact, that owing to its exceptional position the walls should be sufficiently high to enable the lock to be used at all times when the dam can not be passed over in safety. The exact height to be given can be determined by the engineer in charge at some future time; for the present they would recommend that a guard of 14 feet be provisionally adopted.

As it may be feared that the fixed dam with a lock will seriously interfere with the navigation of the unimproved river below the work, by holding the water back during the low-water season, the Board desire to state that they have considered this question, and it is their belief that a low-water discharge at least equal to the present one can be maintained in the Upper Kentucky River through the culverts of the lock, which, if necessary, may be supplemented by valves in the gates. The pool at Beattyville will act as a storage reservoir, from which a constant flow may be drawn in low water, thus filling the same function for the Kentucky River that Lake Pepin does for the Upper Mississippi. By husbanding the rainfall and dealing it out as required it is believed that push-boats will have a much more reliable and useful

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low-water navigation than has hitherto been furnished by the river in its natural state.

The proposed lock can not be begun until 1888, as the whole season of 1887 will be required for quarrying stone. It is therefore recommended that contracts be let at once for the required material, and that the work of laying masonry be begun as soon as possible in the summer of 1888.

In order to prevent embarrassment to navigation before the lock is commenced and during its construction it may become necessary to temporarily remove the two upper steps of the dam. The Board believe that the dam will have to be lowered while the lock is being built, but they recommend that it be retained at its present height, if it can be done without too much detriment to navigation, until the laying of masonry is commenced.

Respectfully submitted,

WM. P. CRAIGHILL,
Colonel of Engineers.
WM. E. MERRILL,
Lieut. Col. of Engineers.
JAMES C. POST,
Major of Engineers.

The CHIEF OF ENGINEERS,
U. S. Army.

DD 7.

OPERATING AND KEEPING IN REPAIR THE FIVE LOCKS AND DAMS ON THE KENTUCKY RIVER.

This work was in charge of Maj. James C. Post, Corps of Engineers, until May 6, 1887, when it was transferred temporarily to my charge.

The following is the most important work that has been done during the year to preserve navigation in its improved condition.

LOCK AND DAM NO. 1.

Removed old sheeting on second step of the dam 192 feet; leveled down and spiked range timbers to their proper level, and replaced sheeting on the same; repaired third step of the dam; built bay-dam 70 feet long and 3 feet high to stop leak and hold up pool; repaired lower step of the dam by building in false crib-work filled with stone; removed stone wall from around site of old lock-house; removed 104 cubic yards of earth in grading banks; raised lower-shore crib one course of ties, and one front-range stick 56 feet; built pier on lower end of same 16 by 14 by 5½ feet.

Dismantled lock-gates and replaced irons; removed 110 cubic yards of old under-water cribbing from lower end of outside wall.

LOCK AND DAM NO. 2.

Cleaned machinery and rigged derrick-boat; 198 cubic yards of material removed in excavating for a foundation for lower shore crib; dam repaired and missing stone replaced.

River crib raised 10 feet and new shore crib built; interfering rock on land side below the lock blasted; abutment double sheeted above the dam; made patterns and measuring poles for use in repairing dam.

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Dredging at this lock consisted of the removal of 2,631 cubic yards of sand, mud, and logs from the lock entrances and vicinity, and placing 644 cubic yards of backing behind the dam.

LOCK AND DAM NO. 3.

Repaired upper and lower cribbing; replaced sheeting on the dam; repaired capstans to the lower lock gates; repaired gate wickets and fences around Government lands; repaired slope wall and did other general work; removed 3,800 cubic yards of sand, etc., from entrance to lock; 2,040 cubic yards from Macy's Bar; 660 cubic yards from Leestown Bar, and 2,335 cubic yards was placed behind the dam as backing.

LOCK AND DAM NO. 4.

Forty pieces of step sheeting to dam replaced by new; repaired old guage posts and made two new ones; repaired operating irons to gates and valves, also the rails on the gates; coffer-dam was constructed across tail bay; head bay was coffer-dammed; the lock pit pumped out in order to repair lower miter-sill; 2,365 cubic yards of sand, etc., removed from lock entrance and vicinity, and 2,000 cubic yards from Clifton Bar. Contracts have been entered into for the construction of keeper's dwelling.

LOCK AND DAM NO. 5.

New operating irons were placed on the gates; slight repairs were made to lock house; four new guage posts were set above the lock and other general work done; removed 1,380 cubic yards of sand, mud, etc., from entrance to lock and vicinity; also 2,982 cubic yards of sand and stone from the channel at Clear Creek Bar.

Navigation was suspended at Lock No. 1 sixteen days on account of ice, twenty days on account of high water preventing boats from passing under railroad bridge at Northville.

Lock-walls were continually submerged from January 28 to April 16, and from April 24 to May 3, 1887. Lock No. 2, fifteen days on account of ice; the lock-walls were submerged for thirty-five days. Lock No. 3, eleven days on account of ice, nineteen days on account of high water. Lock No. 4, ten days on account of ice, twenty days on account of high water. Lock No. 5, two days on account of ice, eight days on account of high water.

New lock-keepers' houses are needed at Locks Nos. 2, 3, and 5. Wells and cisterns are needed at same locks and Beattyville. The paving on the banks above the falls at all the locks is insufficient; it should extend to high-water line, and generally does not extend to within 20 feet of it. The coping and facing of all the lock-walls, with the exception of No. 5, need repairing. New fences are needed around the lock houses and entirely around the United States land at Beattyville. Immediately below all the locks the river has widened, caused by caving and washing of the banks, generally on both sides of the river; this has resulted in a reduction of the depth of the water, especially on the bars immediately below the dams and lock entrances. Permanent works confining the river to its normal width should be constructed. Low, inexpensive wing-dams, throwing the water at medium stage of the river into the channel through these bars, will prevent an annual expense of dredging.

Corporations controlling bridges obstructing navigation should be required to place gauges, clearly defined and marked, on one of the channel piers, both upper and lower sides, for the purpose of showing the amount of head-room at all stages of the river.

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OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION.—MAINTENANCE OF NAVIGATION OF KENTUCKY RIVER, KENTUCKY.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River improved by locks and dams during fiscal year 1886–1887.

LOCK NO. 1.

Period.	Salaries.	Current and contingent expenses.	Repairs.	Dredging.	Total.
1886.					
July	$125.98	.....	.....	.....	$125.98
August	157.16	$7.68	$14.28	.....	179.12
September	144.16	48.62	.....	.....	192.78
October	159.16	19.25	1,799.50	.....	1,977.91
November	159.32	37.00	321.44	.....	517.76
December	163.76	13.38	416.75	.....	593.89
1887.					
January	160.00	19.45	507.36	.....	686.81
February	277.20	24.30	.....	.....	301.50
March	160.00	26.80	.....	.....	186.80
April	277.20	23.76	135.75	$0.49	437.20
May	87.43	413.77	20.99	470.08	992.27
June	48.66	447.12	81.32	321.64	898.74
Total	1,920.03	1,081.13	3,297.39	792.21	7,090.76

LOCK NO. 2.

1886.					
July	$159.32	.....	.....	.....	$159.32
August	159.16	$7.98	$45.63	.....	212.77
September	159.16	56.62	249.83	.....	465.61
October	159.16	43.10	14.40	$961.45	1,178.11
November	159.32	20.00	594.70	.....	774.02
December	163.76	75.58	1,696.87	.....	1,936.21
1887.					
January	160.00	6.78	.....	.....	166.78
February	277.20	19.20	.....	.....	296.40
March	160.00	26.15	.....	.....	186.15
April	277.20	6.98	.....	5.63	289.81
May	95.00	404.89	20.99	470.09	990.97
June	95.00	456.89	81.32	323.73	956.94
Total	2,024.28	1,124.17	2,703.74	1,760.90	7,613.09

LOCK NO. 3.

1886.					
July	$159.32	.....	.....	.....	$159.32
August	159.16	.....	$14.28	.....	173.44
September	159.16	.....	8.20	.....	102.36
October	159.16	$15.70	.....	$1,676.00	1,850.86
November	159.32	19.80	.....	187.46	366.58
December	163.76	22.95	.....	1.02	187.73
1887.					
January	160.00	11.00	15.60	.....	186.60
February	277.20	2.25	10.00	.....	289.45
March	160.00	26.40	.....	.....	186.40
April	277.20	11.72	.....	.....	288.92
May	95.00	410.59	40.79	470.09	1,016.47
June	95.00	457.25	81.32	315.50	949.07
Total	2,024.28	977.66	165.19	2,650.07	5,817.20

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Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River improved by locks and dams, etc.—Continued.

LOCK NO. 4.

Period.	Salaries.	Current and contingent expenses.	Repairs.	Dredging.	Total.
1886.					
July	$159.32	$161.77	$16.36	.....	$337.45
August	159.16	.....	14.28	.....	173.44
September	159.16	6.00	26.55	.....	191.71
October	159.16	20.89	17.85	$1,415.79	1,613.69
November	159.32	19.00	.....	.....	178.32
December	163.76	3.53	.....	.....	167.29
1887.					
January	160.00	1.89	2.50	.....	164.39
February	277.20	3.50	.....	.....	280.70
March	160.00	37.85	.....	.....	197.85
April	277.20	15.83	662.28	.....	955.31
May	95.00	457.60	532.50	470.09	1,554.99
June	95.00	451.40	105.33	314.98	966.71
Total	2,024.28	1,179.26	1,377.45	2,200.86	6,781.85

LOCK NO. 5.

1886.					
July	$159.32	.....	.....	.....	$159.32
August	159.16	$5.00	$14.28	.....	178.44
September	159.16	23.60	.....	.....	182.76
October	159.16	56.49	.....	.....	215.65
November	159.32	41.09	.....	.....	200.41
December	163.76	1.06	.....	.....	164.82
1887.					
January	160.00	.....	348.85	.....	508.85
February	277.20	2.20	106.69	.....	386.09
March	160.00	50.82	20.42	.....	231.24
April	277.20	18.82	50.30	.....	346.32
May	95.00	404.96	20.99	$470.09	991.04
June	99.00	449.88	86.43	315.00	950.31
Total	2,028.28	1,053.92	647.96	785.09	4,515.25

SUMMARY.

Lock No. 1	$7,090.76
Lock No. 2	7,613.09
Lock No. 3	5,817.20
Lock No. 4	6,781.85
Lock No. 5	4,515.25
Total	31,818.15

ABSTRACT OF PROPOSALS RECEIVED BY MAJOR JAMES C. POST, CORPS OF ENGINEERS, DURING THE FISCAL YEAR ENDING JUNE 30, 1887, FOR DREDGING KENTUCKY RIVER, KENTUCKY.

In response to advertisement of August 4, 1886.

No.	Name of bidder.	For dredging (per cubic yard).	For placing the material dredged behind Dam No. 3, additional (per cubic yard).
		Cents.	*Cents.*
1	Coal Transfer and Dredging Company	27	5
2	Benjamin L. Wood, jr	39	28
3	James T. Duffy	43	30

Bids were opened August 21, 1887. Contract awarded Coal Transfer and Dredging Company.

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In response to advertisement of April 13, 1887.

No.	Names of bidders.	For dredging (per cubic yard).	For placing the material dredged behind the dams, additional (per cubic yard).
		Cents.	*Cents.*
1	B. L. Wood, jr	32	20
2	Coal Transfer and Dredging Company	36	14

Contract awarded to B. L. Wood, jr.

ABSTRACT OF BIDS RECEIVED BY MAJOR AMOS STICKNEY, CORPS OF ENGINEERS, DURING FISCAL YEAR ENDING JUNE 30, 1887.

For the construction of a keeper's dwelling at Lock No. 4, Kentucky River, Ky.

No.	Names of bidders.	Price.
1	M. Buckley	$1,660
2	John J. Cox	1,850

Bids were opened at Louisville, Ky., June 15, 1887. Contract awarded M. Buckley.

For the construction of two dump-scows.

No.	Names of bidders.	For constructing dump-scows (price per scow.)	Total cost.
1	Ed. J. Howard	$4,450.00	$8,900.00
2	Samuel W. Coffin	2,448.00	4,896.00

Bids were opened at Louisville, Ky., June 20, 1887, and all rejected as expensive.

REPORT OF MR. R. S. BURNETT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Frankfort, Ky., July 3, 1887.

SIR: I respectfully submit the following report on the "operating and care of canals, etc., and maintaining and preserving navigation on the Kentucky River, Kentucky," for the fiscal year ending June 30, 1887. This work was added to my other charge November 23, 1886, and I relieved Mr. D. L. Sublett December 3, 1886. In submitting my estimate for repairs necessary for the safety of the works and navigation during the fiscal year ending June 30, 1888, only those were reported which could be determined upon at the date of its submittal and that were absolutely necessary. Considerable work not endangering the works or navigation at present is required. New lock-keepers' dwellings are badly needed at Locks Nos. 2, 3, and 5. Wells or cisterns are needed at the same locks, and at Beatyville. The paving on the banks above the walls at all the locks is insufficient—it should extend to high-water line—and generally does not extend within twenty feet of it. Considerable wash has occurred above the present paving, and that adjoining the lock-walls has settled, allowing the water

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to accumulate and drain down under or through the masonry. The coping and faces of all the lock-walls, with the exception of No. 5, need repairing. New fences are needed around all the lock-houses, and entirely around the United States land at Beatyville. Fastenings are needed over all the vertical iron rods operating the valves in the lock-gates, to prevent them from buckling and becoming permanently bent, and all require straightening. The filling and discharge valves in all the walls and lock-gates, excepting Lock No. 5, leak badly and should be replaced with new ones. I am strongly in favor of the substitution of slide-valves for the present butterfly valves. The operating irons on Locks 1, 2, 3, and 4, are cumbersome, and constantly getting out of order; the leverage is poor, making the opening and closing of gates unnecessarily hard. These should be replaced by irons similar to those now in use at Lock No. 5. These do not require to be moved during freshets, are simple in design, and do not require one half the power to operate the gates. Immediately below all the locks the river has widened, caused by caving and washing of the bank generally on both sides of the river, by the reacting water from the dams; this has resulted in a reduction of depth of water, especially on the bars immediately below the dams, and the lock entrances to these bars are continually dredged from year to year. Permanent works, confining the river to its normal width of channel, should be constructed; low, inexpensive wing-dams, throwing the water at medium stage of the river into the channel through these bars, will prevent this annual expense of dredging. A test of the gauges at the several locks show them to be incorrectly graduated, some being out as much as 5 inches from the miter-sill to the tops of the lock-walls. All the gauge-posts require resetting, and one half regraduating. Levels taken on the heel and toe of all the gates show a settlement of from one-half of an inch to 5 inches, with the exception of Lock No. 5, where only the upper outside gate was found to be about one-half inch low at the toe. The adjustment of these gates is now in progress. The stage of water prevented an inspection of the dams until the last day of the year, when the river was found sufficiently low. Corporations controlling bridges obstructing navigation should be required to place gauges clearly defined and marked on one of the channel-piers, both upper and lower side, for the purpose of showing the amount of head room at all stages of the river.

DAM NO. 1

Shows no serious damage from ice and floods; no sheeting has been displaced; a few defective pieces require replacing; no settlement has taken place, excepting at the abutment, where it is about 1 inch, the water spilling uniformly over the remainder. A slight settlement shows in the abutment above the dam. The dam leaks badly and will require about 5,000 cubic yards of backing. The breach remains in about the same condition as last year. Considerable breach-cribbing was washed away during the spring freshets, that remaining being in a very bad condition and of little use. The foundation of the lower inside guide-wall is in a very precarious condition. New work has been constructed from an elevation of about 11 feet above the lower miter sill to within a few feet of the top of the lock-wall. This new work has been set back from the face of the old cribbing about 2½ feet, the old cross-ties being generally without bearing and rotten. This projection is very dangerous to navigation, and the entire wall should be reconstructed before adding additional height to it. Several years ago the lower river guide-wall was shortened about 50 feet; it was only removed to a reading of 8 feet on the lower miter-sill, making it exceedingly dangerous to navigation. Several boats have been damaged by running on it. It also caused the bar making out from the bank immediately below the entrance to increase in size, making the approach difficult. This is now being removed. During a freshet this spring one of the lower gates broke from its fastenings and closed, breaking the heel castings and damaging the miter-sill. A new lower miter-sill will be necessary. In periods of freshets, owing to backwater from the Ohio, it is necessary to fasten these gates back in their recesses by extra fastenings; the damage done was unquestionably due to carelessness. Several timbers will be required to replace rotten and defective ones in these gates. An examination of the tail-bay was made. The sheeting which extended below the miter-sill 40 feet has been washed out; the timbers underneath, which were let into and wedged into the walls, are loose; a large number have been washed away, and the soap-stone rock has worn away as much as 2½ feet in places. The water has been acting on this for several years.

Repairs, etc.—Operating and care of the locks.—Removed old sheeting on second step of the dam 192 feet; leveled down and spiked range timbers to their proper level, and replaced sheeting on the same; repaired third step of dam; sheeted up abutment cribbing from crown of dam to end of lower step; built bay dam 70 feet long, three feet high, to to stop leak and hold up pool; repaired lower step of dam by building in false crib-work filled with stone; replaced old sheeting and drove down all projecting spikes; removed stone wall from around site of old lock-house; removed 104 cubic yards of earth in grading banks between lock-house and pike, and lock-walls and pike; raised lower

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shore-crib one course of ties, and one front-range stick 56 feet; built pier on lower end of the same 16 by 14 by 5½ feet; filled crib and pier-head with stone; extended stone steps from end of upper retaining-wall up to pike, 27 by 3½ feet wide; paved bank on each side of steps up to pike, about 35 cubic yards of stone used in paving; built steps from lock-wall to pike; cleaned snow and ice from lock-walls; repaired fences and set water-gauges; dismantled lock-gates and replaced irons; removed 110 cubic yards of old under-water cribbing from lower end of outside wall; removed drift from upper and lower approaches to lock and from the dam; painted lock-gates and irons, also upper and lower gauges on lock-wall; graded and sodded bank in rear of lock-house; sowed grass seed in front of lock-house, and cared for Government premises and tools.

Suspension of navigation at this lock and vicinity was as follows: Sixteen days in January on account of ice, twenty days on account of high water preventing boats from passing under the railroad bridges at Worthville. Lock-walls were continually submerged from January 28 to March 16, and from April 24 to May 3, a total of fifty-eight days.

The highest water occurred March 1, when the upper gauge read 51′.60; lower, 37′. The lowest occurred October 29, the upper gauge reading 5′.10, the lower 4′.50. One coal-barge was sunk, and several crafts damaged by striking under-water cribbing.

Project for the fiscal year ending June 30, 1888.—Building extension to new abutment; building new breast to dam; raising lower-river guide cribbing; raising lower-shore guide cribbing; building retaining-wall upper-shore crib; paving bank between upper-shore crib and pike; constructing triangular guide-piers above upper-river cribbing.

DAM No 2.

With the exception of several pieces of slope sheeting washed away no damage has been done. The dam leaks in several places, the worst about 60 feet from the abutment. Two thousand cubic yards of backing will be required to make this dam comparatively tight. The foundation of the guide-walls is generally bad, but in no danger of giving away at present.

At the abutment, half-way down the reverse slope, several timbers have been broken out of the face, leaving a hole 5 by 3 by 4 feet. The foundation of the extension of the abutment below the dam has washed out considerably; the timbers remaining are rotten; those washed out have allowed the stone to fall out of the cribs.

Several defective timbers in the gates require replacing. Dredging is required at both the upper and lower entrances, also at Clay lick and bar, immediately below. With the water on a level with the comb of Dam No. 1 there is 5 feet 7 inches on the lower miter-sill of the lock.

Repairs, etc.; operating and care of lock.—Reset screws to wickets on lower lock-gates. Cleaned machinery and rigged derrick-boat. One hundred and ninety-eight cubic yards of material was removed in excavating for a foundation for lower shore-crib. Placed 50½ cubic yards in dam. Made and repaired 225 spikes. Repaired derrick-irons and inspirator on derrick-boat. Dam repaired and missing stone replaced. River-crib raised about 10 feet. New shore-crib built; interfering rock on land side below the lock blasted. Abutment double-sheeted above the dam. Removed six logs out of the channel, also drift from dwelling to lock and ice from upper cribbing. Made patterns and measuring poles for use in repair to dam. Set gauge-posts above upper entrance. Suspension of navigation at this lock was as follows:

Fifteen days in January on account of ice and five days on account of high water. The lock-walls were submerged thirty-five days. Highest water occurred February 28, the upper gauge reading 51′.00; lower, 9′.00. Lowest occurred on the lower gauge November 3, the gauge reading 2′.50, the upper reading 7′.60.

The lowest on the upper gauge occurred on November 9, reading 6′.30, the lower 4′.20.

Dredging at this lock consisted of the removal of 2,631 cubic yards of sand, mud, and logs from the lock entrances and vicinity, and placing 644 cubic yards of backing behind the dam.

Project for the fiscal year ending June 30, 1889.—Raising upper-river cribbing. Raising lower-river guide cribbing. Building lower-land guide cribbing. Repairing dam and abutment. Raising upper-land inside cribbing. Constructing triangular guide-piers above upper-river cribbing. Dredging entrances and bars. Backing dams.

DAM NO. 3.

A few pieces of sheeting have been washed away from this dam. No serious damage has occurred, but little leakage has developed, and the dam will require but little backing. The dam is about 9 inches too high at the abutment; the foundation of the guide-walls are in a bad condition. The crib-jetties constructed below the abutment,

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from their location, have accelerated the cutting of the bank; large slides have occurred; the bank has been broken behind. Those extending above the return wing of cribbing below the abutment being constructed too far apart in proportion to their length, the current was not maintained to their heads, resulting in strong reaction between them. They should be removed or modified, and additional jetties constructed for the safety of the work. Dredging is required at the entrances and bars below this dam. With the water on a level with the comb of dam at No. 2 there is 6 feet 7 inches on the lower miter-sill of this lock.

Repairs, etc.; operating and care of lock.—Repaired upper and lower cribbings. Replaced sheeting on the dam. Repaired capstans to lower lock-gates. Repaired gate-wickets and fences around Government land. Cleaning and caring for machinery on derrick-boat. Repaired slope-wall and other general work.

Suspension of navigation of this lock was as follows: Eleven days in January on account of ice. The lock-walls were submerged nineteen days. Highest water occurred February 28, upper guage reading 45′.9; lower, 33′.2. Lowest water occurred November 10, upper guage reading 7′.60; lower, 5′.

One coal-boat was damaged by striking the lower wall.

Dredging at this lock consisted in the removal of 3,800 cubic yards of sand, etc., from the lock entrances, 2,640 cubic yards from Macy's Bar, 660 cubic yards from Leestown Bar, and 2,335 cubic yards placed behind the dam as backing.

Project for the fiscal year ending June 30, 1888.—Building lower-river guide cribbing. Raising upper inside guide cribbing. Raising cribbing below dam. Completing upper-river guide cribbing. Constructing triangular guide piers above upper-river cribbing. Repairing and backing dam. Dredging entrances and bars.

DAM NO. 4.

With the exception of seven pieces of sheeting torn off from the steps by ice, no serious damage has been done. The dam is tight and requires no additional backing. Dredging is required in the entrances and at the bars below. With the water at a level with the comb of Dam No. 3, there is 6′.27 water on the lower miter-sill.

Repairs, etc.—Forty pieces of step sheeting to dam replaced by new. Repaired old gauge-posts and made two new ones. Repaired operating irons to gates and valves; the rails on the gates were also repaired. Coffer-dam was constructed across tail bay, the head bay coffer-dammed, the lock-pit pumped out. The lower miter-sill, which had lifted, raising the mud-sill and grouting between them with it, was repaired by putting in 16 new bolts 1¼ inches by 8 feet, and replacing in the old holes 8 bolts 1¼ inches by 4 feet. These old bolts entered the rock from 3 inches to 7 inches, and were split and wedged; the new bolts were put down 5 feet into the rock, the ends painted and bended and driven into a plug in the bottom of the hole; the hole was then filled with sand around the bolts. The space between the sills was filled with three courses of 3-inch oak sheeting, oakum placed between each course, and the sheeting spiked to the floor, independent of the sills; cement was then filled in the space remaining to the top of the sills. Two strips of oak 6 by 10 inches by 18 feet were placed above the sill and spiked to the floor, and drawn tight against the face of the sill, this to prevent leak under the sills should they raise less than 6 inches. The lower portion of the gates were painted before filling the lock-pit. Four check-posts were set on the bank above the lock. The gates were adjusted and painted and other general work performed. Suspension of navigation at this lock was as follows:

Ten days by ice, 4 days by high water, 32 days making repairs to lower miter-sill. The lock-walls were submerged 16 days. Highest water occurred February 28; upper guage read 47′.30; lower, 33′.40. Lowest water occurred November 7; upper guage read 5′.30; lower, 4′.80. One loaded coal barge broke loose from the steamer *Combs*, as she was coming out of the upper entrance, and swung around the upper-river wall and passed over the dam. There was 5 feet of water running over the dam. The barge, with contents, was a total loss.

Dredging at this lock consisted in the removal of 2,365 cubic yards of sand, clay, and drift from lock entrance and vicinity; also 2,000 cubic yards from Clifton Bar.

Project.—Raising lower-river guide cribbing. Constructing triangular guide-piers above upper-river cribbing. Constructing a single lock-house. Repairing dam and dredging entrances and bars.

DAM NO. 5.

The only damage to this dam has been caused by leakage, resulting in settlement. The difference in level of the comb of the dam between that portion adjoining the abutment and the center is 13 inches; all the steps have settled, and the dam leaks badly. Two thousand yards of backing will be required. I do not deem it advisable to level up the comb of this dam until the cribbing has reached a firm bearing on its foundation of rock. Excavation was made in constructing this, presumably to solid rock; this settlement, however, indicates that all the material overlaying the rock was

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not removed. Dredging is required at the entrance to this lock, also at Clear Creek Bar, in the upper portion of the pool, and at one bar below the lock. With the water level with the comb of the dam at No. 4, there is 6′.30 of water on the lower miter-sill.

Repairs, etc.—New operating irons were placed on the gates. With the lower gauge reading 6′.30, and the upper 8′.30, these gates can now be opened and closed with three men in 34 seconds, with two in 37 seconds. Slight repairs were made to lock-house. Four new gauge-posts set above the lock. The gates were painted, and other general work done.

Suspension of navigation at this lock was as follows:

Two days on account of ice. Lock-walls submerged 8 days. Highest water occurred February 27; upper gauge, 45′.20; lower, 33′.60. Lowest water occurred November 5; upper gauge, 5′.90; lower, 5′.40.

Dredging at this lock consisted in the removal of 1,380 cubic yards of sand, mud, and logs from the lock entrances and vicinity; also 2,982 cubic yards of sand and stone from the channel at Clear Creek Bar.

Project.—Repairing lock-keeper's house. Constructing triangular guide-piers above upper-river cribbing. Dredging entrances and bars. Backing dam.

SNAGBOAT KENTUCKY.

The boat was completed and placed in commission on the 16th day of October, 1886, remaining in commission until the 7th of December, when she was laid up at Carrollton, Ky., until the 27th of February, 1887, when she was again placed in commission and ordered to the Upper Kentucky River, returning April 7 to Lock No. 4, aiding in the repairs to the lock. From May 26 to June 19 she was laid up at Lock No. 1, her crew operating the lock and making necessary repairs, which were as follows:

Painting the entire boat inside and outside; new bed-plates to capstan was placed; exhaust-pipes were placed in stern of the boat, discharging into the wheel; braces were placed under ridge-pole, supporting cabin over boiler; frame made for 12-inch pump and securely bolted behind capstans; the wheel was cut down 5 inches, and hold thoroughly cleaned out; spike and sounding poles made and painted; machinery thoroughly overhauled and cleaned.

WORK DONE DURING THE YEAR ENDING JUNE 30, 1887.

Obstructions removed	number..	802
Miles run	do...	1,840
Working at Lock No. 4	days..	36
Working at Lock No. 1	do...	5
Laid up in winter quarters	do...	82
Laid up making repairs and painting	do...	25
Work done in the vicinity of Beattyville:		
Obstructions removed	number..	265
Miles run	do...	378
Work done between Oregon and mouth of river:		
Obstructions removed	number..	537
Miles run	do...	1,462

STEAM DERRICK-BOAT.

Repaired one hoisting iron and made a new one; removed old oakum and recalked the entire boat; repaired bottom and gunwales.

Rules and regulations governing navigation were issued.

I wish to attest my appreciation of the services of Mr. A. L. Greenhow, inspector and clerk, and James F. Browinski, of the snag-boat, in their respective capacities.

The following papers accompany this report: Report of commercial statistics for the fiscal year ending June 30, 1887; report of lockages for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

R. S. BURNETT,
Assistant Engineer.

Second Lieut. E. J. SPENCER,
Corps of Engineers, U. S. A.

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Report of lockages for the fiscal year ending June 30, 1887.

Locks.	Number of days operated.	Number of days suspended.	Going up.			Going down.				Total craft and flats passing locks.	Total number of lockages.
			Steam-boats.	Barges and flats.	Miscellaneous.	Steam-boats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1	349	16	311	138	108	310	143	175	125	1,310	1,119
No. 2	345	20	206	106	116	265	124	153	105	1,135	1,035
No. 3	354	11	275	132	112	270	137	99	112	1,137	1,016
No. 4	319	46	252	101	94	239	99	178	63	1,006	806
No. 5	363	2	220	173	64	219	168	1,028	76	1,948	1,398
	1,730	95	1,304	650	494	1,303	671	1,633	481	6,536	5,374

Total increase of lockages over the fiscal year ending June 30, 1886, 422.

COMMERCIAL STATISTICS.

Lower Kentucky River, Kentucky, for fiscal year ending June 30, 1887.

Articles.	Quantity.	Average price.	Value.
Apples ..... barrels	157	$2 per barrel	$314.00
Barrels (empty) ..... number	66	1.50 each	99.00
Beer ..... cases	275	$2 per case	550.00
Cement ..... barrels	85	$1.50 per barrel	127.50
Coal ..... bushels	778,304	11 cents per bushel	85,613.44
Cattle ..... head	1,224	$40 a head	48,960.00
Country produce	.....	.....	12,297.00
Flour ..... barrels	1,801	$6 per barrel	10,806.00
Grain ..... bushels	455,953	70 cents per bushel	319,167.10
Hides ..... number	147	$4 each	588.00
Hay ..... tons	1,489	$14 per ton	20,846.00
Horses ..... head	285	$125 a head	35,625.00
Hogs ..... do	5,991	$8 a head	47,928.00
Hogsheads ..... number	690	$2.50 each	1,725.00
Iron, manufactured ..... tons	2,545	$50 per ton	127,250.00
Junk ..... do	44	$20 per ton	880.00
Lumber ..... feet B. M	1,181,487	$16.50 per thousand	19,494.53
Laths ..... number	26,201	$2.50 per thousand	65.50
Logs, walnut ..... do	15,752	$15 each	236,280.00
Logs, assorted ..... do	67,164	$5 each	335,820.00
Lime ..... barrels	1,346	$1 per barrel	1,346.00
Posts, cedar ..... number	43,091	20 cents each	8,618.20
Shingles ..... do	50,313	$3 per thousand	150.93
Sheep ..... do	1,652	$3.50 each	5,782.00
Staves ..... do	290,200	$25 per thousand	7,255.00
Salt ..... barrels	2,462	$2 per barrel	4,924.00
Stone, riprap ..... cubic yards	27,000	$1.25 per cubic yard	33,750.00
Stone, building ..... do	1,196	$10 per cubic yard	11,960.00
Stoneware ..... gallons	1,000	8 cents per gallon	80.00
Timber ..... linear feet	24,000	15 cents per linear foot	3,600.00
Tobacco ..... hogshead	17,943	$100 per hogshead	1,794,300.00
Ties, railroad ..... number	114,982	40 cents each	45,992.80
Wood ..... cords	2,285	$3.50 per cord	7,997.50
Whisky ..... barrels	18,530	$130 per barrel	2,408,900.00
Merchandise ..... tons	18,691	$200 per ton	3,738,200.00
Passengers ..... number	18,557	Fare $1.50 each	27,835.00
Total	.....	.....	9,405,128.00

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D D 8.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

This work was in charge of Maj. James C. Post, Corps of Engineers, until May 6, 1887, when it was transferred temporarily to my charge.

This river is a tributary of the Ohio, and empties into it 79 miles below Evansville, Ind.

The project for the improvement of the river contemplates the formation of a clear channel at least 40 feet in width, with a minimum depth of 2½ feet, during eight months of the year.

The work on the Tradewater River consisted of removing obstructions from the channel of the river and cutting off deadened timber from the banks. These operations were extended 400 yards above Fish Trap Ford, or a distance of 24½ miles from the mouth of the river. Cold weather compelled stoppage of operations in December, 1886, and nothing has been done since except the removal of drift gorges.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886	1,450.34
July 1, 1887, amount available	549.66
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Efforts were made to obtain statistics of the commerce of the year, but nothing was received, and the table of last year is given:

Commercial statistics for fiscal year 1885–'86.

Articles.	Quantity.	Average price.	Value.
Apples, dried ..... pounds..	23,000	3 cents per pound	$690
Butter ..... do....	900	25 cents per pound	225
Coal ..... barges..	900	$84 per barge	75,600
Corn ..... bushels..	75,000	40 cents per bushel	30,000
Feathers ..... pounds..	27,000	50 cents per pound	13,500
Lumber ..... feet, B. M..	5,250,000	$12 per M	63,000
Oats ..... bushels..	17,000	32 cents per bushel	5,440
Potatoes ..... do....	8,000	53 cents per bushel	4,240
Peaches, dried ..... pounds..	14,000	5 cents per pound	700
Staves, oak ..... number..	6,000,000	$15 per M	90,000
Timber, in log:			
Poplar ..... cubic feet..	1,236,000	12 cents per cubic foot	148,320
Oak ..... do....	975,400	15 cents per cubic foot	146,310
Walnut ..... do....	2,000	55 cents per cubic foot	1,100
Sweet gum ..... do....	20,000	10 cents per cubic foot	2,000
Tobacco ..... hogsheads..	900	$75 per hogshead	67,500
Wool ..... pounds..	50,000	30 cents per pound	15,000
Wheat ..... bushels..	250,000	80 cents per bushel	200,000
Total			863,625

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DD 9.

REPORT ON EXAMINATION AS TO WHETHER OR NOT THE GOVERNMENT DRY-DOCK AT THE LOUISVILLE AND PORTLAND CANAL IS ADEQUATE FOR THE PURPOSES OF COMMERCE, AND WHAT ALTERATIONS, IF ANY, ARE NECESSARY, AND THE COST OF MAKING THE SAME.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., January —, 1887.

GENERAL: I have the honor to submit the following preliminary report upon the subject as to whether or not the Government dry-dock at the Louisville and Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making the same.

The instructions from your office require that in this report an opinion should be given as to whether the dry-dock is worthy of improvement. In order to obtain information upon this point I addressed letters to various parties interested in the running of steamers and to the proprietors of facilities for repairing boats, asking their views in this matter—

First. As to what the purposes of commerce require.

Second. As to how they are now served.

Third. As to whether there is any commercial necessity for an improvement of the docking facilities now existing at the canal.

I have received but few replies, copies of which are inclosed.

It appears to me that the worthiness of the improvement of the docking facilities of the Louisville and Portland Canal depends upon the policy which those in authority may deem proper, with regard to the Government furnishing facilities which can be, and to a considerable extent are, furnished by private corporations and individuals, and which constitute a distinct branch of business.

The purposes of commerce require establishments with such facilities as will admit of the repairing of the largest boats that navigate the river, and sufficient in number to accommodate all vessels needing repairs without great delay.

To furnish such facilities a dock or ways should be able to take a boat 310 feet in length and 80 feet in width.

The existing dry-dock at the Louisville and Portland Canal is only of sufficient size to admit boats 180 feet or less in length and 50 feet or less in width. It is ample, however, for all of the vessels that are used in connection with the operating of the canal—the dredges, steam tow-boats, scows, barges, etc., and for numerous steam-boats of the smaller class, that are used for low-water navigation and for navigating the tributaries.

There are facilities in the shape of marine ways and floating docks for the repair of boats of all sizes at various points along the Ohio River from Pittsburgh to Cairo.

At Allegheny, opposite Pittsburgh, there are marine ways with capacity for the largest boats. At and in the vicinity of Pittsburgh there are numerous private ways and floating docks for the repair of coal boats and barges.

At Pomeroy there are ways for the smaller class of boats.

At Cincinnati there are ways and a floating dock with capacity for the largest boats.

At Covington there are ways for small boats.

At Madison there are ways for the largest boats, but they are not available at a low stage of the river.

At Paducah there are ways for the largest boats.

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At Mound City there are ways for the largest boats.

The enlargement of the Government dry-dock would therefore appear not to be an absolute necessity of commerce, though it would undoubtedly be a great convenience, and would probably furnish facilities superior to any on the river.

In one sense, then, the existing dry-dock is not adequate for the purposes of commerce, inasmuch as it will not admit vessels of the larger class. In another sense it is adequate for the purposes of commerce, because it is sufficient in size for the repair of all vessels used in keeping the canal in navigable condition and numerous others, while vessels of larger class can be accommodated at other places.

A survey and estimate of cost for a larger dry-dock can be made by this office without additional funds, and report and estimate will therefore be submitted.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF MR. D. C. ROBINSON, SUPERINTENDENT.

MADISON, IND., *November* 24, 1886.

DEAR SIR: Replying to yours of the 22d, will say that in regard to the facilities offered by the Government dry-dock in the Louisville and Portland Canal:

Your first query, "What do the purposes of commerce require?"

Would say that the answer would be, the river interest requires that there should be docks or marine railways sufficient to meet the repairing of all the tonnage on the river.

Secondly, "How are they now served?"

Hitherto there has been no lack of facilities, but the facilities have rather been in excess of the demand. The various marine railways and dry-docks on the river have not, as an average, been employed more than half the time. It is true that at times work comes in a rush because owners of boats will run as long as there is water, and then when the water is low and they can not do anything else they all want to come out at once and have their work done in a hurry.

Thirdly, "Is there any commercial necessity for improvement of the docks now existing at the canal?"

We do not think there is any such necessity. From Pittsburgh to Cincinnati the river is studded with docks. Commencing at Pittsburgh, where the coal boats are well taken care of, we find three docks between there and Cincinnati. At Cincinnati we find extensive docks and marine railway; at Madison a marine railway now undergoing extensive repairs and being put in such a condition that it will be ready to handle the largest boats on the river.

At Mound City and Paducah we find marine ways capable of handling the largest boats.

Respectfully submitting these views, we are,
Yours, very respectfully,

D. C. ROBINSON,
Superintendent.
Per GEO. W. PALMER,
Treasurer.

Maj. AMOS STICKNEY,
U. S. Engineer.

LETTER OF MR. C. M. HOLLOWAY.

CINCINNATI, *November* 27, 1886.

SIR: The purposes of commerce require clear channel-ways with ample room for safe navigation, coupled with all the legitimate Government improvements of the natural water-ways that will contribute to cheapen the movement of the products of this great mineral and agricultural territory, that is drained by our navigable waters.

Second. They are now served principally by water transportation, while the water-ways are continuously endangered and threatened by the building of stone obstruc-

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tions by railroad corporations, commonly called bridge-piers, which the Government should never suffer to be placed as a menace or hinderance to safe and cheap transportation.

Third. There is a commercial necessity for the improvement of the docking facilities now existing at the Louisville Canal. As I understand it, the present docks can only accommodate the small class of steamers, while our large boats have been detained as long as sixty and ninety days waiting for dock facilities, in order that necessary repairs could be made to render said steamers seaworthy. There are very poor docking facilities at this port, and still poorer at Madison, Ind. A boat of ordinary tonnage can not be hauled out or launched at the Madison ways at a less stage of water than 8 feet on the gauge between here and Louisville, which renders said ways inoperative during the low-water season, the particular time when it is important to put steam-boats in repair and get them ready to ply their trades at the opening of navigation.

Very respectfully, your obedient servant,

C. M. HOLLOWAY, *G. M.*

AMOS STICKNEY, Esq.,
Major of Engineers, U. S. A.

LETTER FROM THE PRESIDENT OF THE CINCINNATI DRY-DOCK COMPANY.

CINCINNATI, OHIO, *December* 13, 1886.

SIR: Some time since we received a letter from you asking our views on the subject of the Government building a dry-dock at the Louisville and Portland Canal.

After taking the subject into consideration for some time, we come to the conclusion that there is no necessity for such a dock being built, as the docking facilities are adequate, and more so, as the seasons for docking last only during the time while there is low water.

Boats have been accommodated for years with the docks and marine ways that are now in use, and instead of steamers being built to run in new trades they are worn out and quit, with nothing to fill their places; in that way the number are decreasing instead of increasing, while the same number of marine ways and docks are still in use. At Cincinnati there are a set of sectional docks that have been put in good repair this last spring. While the low-water season was they had work for 131 days. Since the 25th of November they have been idle and will remain so until next low water, perhaps July. The same may be said of the marine ways.

How can the United States Government expect to do business in a town like Louisville, where there is only one packet line that makes it its headquarters (that can not be accommodated on the dock there now), without conflicting with either Cincinnati or Pittsburgh, while both dock companies have been doing the work and their plants lying idle over half the time. Louisville boats either come to Cincinnati or Madison, Ind., and had their work done, while now it seems as though Louisville wanted a dock at the Government expense and for Louisville's benefit. Why not buy the docks and ways at Cincinnati for the interest of Cincinnati steamboatmen? They are as deserving of it as Louisville parties, while the interest of steamboatmen are a great deal more than they are at Louisville.

If the Government build a dock at Louisville it will be in conflict with the business. As it now is (private concerns) there is not enough work to do justice to the capital invested, and with a dock company run by the Government we will be forced to quit. There are large docks, capable of taking out any size boat that plies on the Ohio: At Pittsburgh, Pa., dock; Cincinnati, Ohio, dock and marine ways; Madison, Ind., marine ways; Paducah, Ky., marine ways; Mound City, Ill. (Cairo), marine ways; Saint Louis, Mo., docks and marine ways.

This does not include the small docks and ways situated from Pittsburgh to Cairo, too numerous to mention. Below we give you a statement of repair work done since 1878, each year separately, with docking during the season of low water (there may be a case when a boat came in and had to get to dock by being disabled).

Tonnage, as custom-house measurement (hull or under tonnage).

There may be a difference in the tonnage of some tow-boats, but you will find it to be near correct. (Model barges and steamboat hulls are not included in the tonnage and not as freight and passenger boats, but separately).

Very truly, yours.

THE CINCINNATI DRY-DOCK COMPANY,
H. CORNEL,
President.

AMOS STICKNEY,
Major of Engineers, U. S. A.

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Repair work since 1878.

Year.	Steam, freight, and passenger vessels.		Steam towing vessels, not including tugs.		Steam ferry-boats.	Steam tugs.	Model barges.	Coal floats, etc., and small sand boats.	Total water craft of all descriptions.
	No.	*Tons.*	*No.*	*Tons.*					
1878	30	10,107	2	566	2	.....	4	1	39
1879	27	10,019	2	412	2	1	1	.....	33
1880	17	6,386	5	493	1	.....	7	1	31
1881	23	8,319	9	1,870	4	.....	10	.....	46
1882	23	7,940	11	2,811	4	2	5	5	50
1883	15	6,478	3	418	2	1	3	1	25
1884	6	2,975	9	1,659	2	1	11	1	30
1885	8	3,719	5	978	2	3	7	1	26
1886*	7	4,107	7	1,567	3	2	2	4	25

* All the work this year was done in 131 days, including everything.

LETTER FROM THE PRESIDENT OF THE LOUISVILLE AND EVANSVILLE MAIL COMPANY.

LOUISVILLE, KY., *January* 11, 1887.

DEAR SIR: Replying to your favor in regard to enlarging the Louisville and Portland Canal Dock, I inclose letter from United States Supervising Inspector Dugan, showing tonnage, number of boats registered, etc., at this port.

In answer to your questions, would say that the present dock is entirely too small for the boats plying the Ohio River, only the very smallest being able to get on the Cumberland, and other tributaries only getting the benefit by docking there at present. The only ways that are available now are Madison, at certain stages of the river; Paducah, when you can get there, or Cincinnati, all of which are in bad order.

The danger of crossing the falls, where boats are often damaged, demands a larger dock, as to go to either of the places above mentioned causes great risk and expense.

Last fall the steamer *Diurnal* sunk 60 miles below Louisville, was raised and brought safely to Louisville, but on her way to Madison the temporary bulkhead gave way and she sunk to her roof and had to be wrecked. If the dock at the canal had been adequate she could have been docked here and saved.

In the year 1882 three of our side-wheel boats were sunk on the falls. We were put to the expense of going to Cincinnati, costing us 25 per cent. more than it would have here.

Commerce needs docking facilities now more than ever, as the railroads have so encroached upon the river interest that private enterprise would hardly be justified in building and operating docks.

Our company docked five boats this season; two of them we had to take to Paducah (350 miles) and three to Madison, where there is great danger in docking, as in high water you are liable to be floated off and in low water you are frequently caught on the ways without water enough to launch. I shall be glad to give you any further information you may want on this subject.

Yours, truly,

W. W. HITE,
President.

Maj. AMOS. STICKNEY,
United States Engineer.

LETTER FROM MR. IRWIN DUGAN, SUPERVISING INSPECTOR STEAM VESSELS SIXTH DISTRICT.

OFFICE OF UNITED STATES SUPERVISING INSPECTOR OF STEAM VESSELS,
Louisville, Ky., December, 23, 1886.

DEAR SIR: During the year 1886 we have inspected in the Louisville district 65 steam vessels, aggregating 11,275 tons net.

The canal docks are not large enough at present to be used by any but the smaller vessels. It would be a great benefit to commerce if the docks were large enough to

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admit vessels of 300 feet in length. At present vessels of that size are compelled to go to Paducah, Ky. (350 miles distant), for repairs.

I hope Major Stickney, the engineer now in charge of the canal, will use his influence to have the docks enlarged to meet the demands of the larger steamers.

Very respectfully,

IRWIN DUGAN,
Supervising Inspector Steam Vessels, Sixth District.

Col. W. W. HITE,
President L. and E. Mail Company.

REPORT AND ESTIMATE OF THE COST OF ENLARGING THE DRY-DOCK AT THE LOUISVILLE AND PORTLAND CANAL.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., January 21, 1887.

GENERAL: I have the honor to submit the following report upon the question as to whether or not the Government dry-dock at the Louisville and Portland Canal is adequate for the purposes of commerce, and what alterations, if any, are necessary, and the cost of making the same:

The reply to the question as to whether or not the existing dry-dock is adequate for the purposes of commerce depends upon the intention of the inquiry. If the dock is to be considered in connection with the other establishments along the Ohio River, where vessels of all sizes can be accommodated for repairs, there would seem to be no pressing demand for any increase in size, as there are various points along the river at which vessels of all sizes can be taken out of the water for repair, and they are not so overcrowded with work as to show an inadequacy of accommodation.

The largest vessels can be taken out at the following places: Allegheny, Pa.; Cincinnati, Ohio; Madison, Ind.; Paducah, Ky.; Mound City, Ill.

In addition to these there are numerous ways for smaller vessels.

Considering the existing dock independently of other establishments, it is entirely too small for the admission of many steamers that navigate the Ohio River. It will not accommodate vessels that are over 180 feet in length or 50 feet in width. To be adequate for the purposes of commerce, it should be of sufficient size to take in vessels 310 feet in length and 80 feet in width. A proper increase of size of the dock would largely add to the facilities of the river commerce, in providing a convenient place of repair which would be far superior to any other establishment on the river. Steamboats that navigate Western rivers are so built that they often lose their shapes either from unequal loading, striking bars, or giving way of some of their parts. It is very desirable to have facilities for regaining shape, and it is said that the existing dry-dock, owing to its unyielding rock bottom, offers better facilities for this, for such boats as can get into it, than any other place. An enlarged dock would offer such facilities for the largest steamers.

Several projects have been made for a large dry-dock at the Louisville and Portland Canal.

The one that I present is for an enlargement of the present dock without materially changing the location. The enlargement of the dock will render it necessary to change the highway bridge across the old locks.

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The following is an estimate of the cost, prepared by my assistant, Lieut. E. J. Spencer, Corps of Engineers:

Items.	Cubic yards.	Cost per cubic yard.	Total cost.
Earth excavation	45,370	$0.30	$13,611.00
Rock excavation	15,830	1.50	23,745.00
Removing old paving in present dock	382	1.00	382.00
Paving new slopes	1,662	2.25	3,739.50
Masonry for gate abutments and mitre-sill	2,715	20.00	54,300.00
Canal-wall, retaining-wall, and stair-way	5,668	12.00	68,016.00
Lock-gates, wooden, 18 feet lift			12,000.00
Gate machinery			3,000.00
Outlet culvert			8,000.00
Blocks			5,000.00
Pumping machinery and well			15,000.00
Filling behind walls	2,625	.20	525.00
Total for dock proper			207,318.50
New iron bridge			25,000.00
Piers and abutments, masonry	2,025	12.00	24,300.00
Earth excavation for same	2,140	.30	642.00
Filling behind abutments and approaches	7,098	.20	1,419.60
			258,680.10
Contingencies, 20 per cent			51,736.02
Total of estimates			310,416.12

This estimate is for a dock 350 feet in length, 100 feet in width, with an entrance 80 feet wide, and which would permit the docking of vessels from the lowest stage of the river up to 14 feet above low water.

The excavation and furnishing of material for this work might be done by contract, but the work of construction should, in my opinion, be done by hired labor.

Very respectfully, your obedient servant,

AMOS STICKNEY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

D D 10.

PRELIMINARY EXAMINATION OF POND RIVER, KENTUCKY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 20, 1887.

GENERAL: In accordance with the instructions contained in Department letter of September 27, 1886, I have to submit the following report of the preliminary examination of Pond River, Kentucky.

Pond River, a tributary of Green River, is a narrrow crooked stream. It is principally used for floating logs to market. Its capacity is so small that it is hardly probable that any improvement would develop much commerce.

It is not therefore considered worthy of improvement.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers,

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

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D D 11.

PRELIMINARY EXAMINATION OF THE LOUISA [LEVISA] FORK OF SANDY RIVER, VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 20, 1887.

GENERAL: In accordance with the instructions contained in Department letter of September 27, 1886, I have to submit the following report of the preliminary examination of the Louisa [Levisa] Fork of Sandy River, Virginia.

An examination and report upon this portion of the Levisa Fork of the Big Sandy River was submitted by Lieut. Col. W. E. Merrill, Corps of Engineers, in 1876, and printed in the Annual Report of the Chief of Engineers of that year, pages 140 to 146, Part II. The recent examination made in compliance with the instructions received confirms the facts ascertained and stated in the former report. It extended from the State line of Virginia to the mouth of Dismal Creek, a distance of 23 miles. This stream flows through a sparsely settled country, in which the majority of the people are engaged in cutting and rafting logs. The only improvement asked for is the removal of trees, snags, and rocks, and the closing of duplicate channels, so that the logs can be brought to market without so great a risk and percentage of loss.

This stream is deemed worth of improvement to this limited extent, which will only require the expenditure of a small amount. No additional survey is necessary. It is estimated that the cost of all the work to be done will probably not exceed $250 a mile, or a total of $5,750. Any appropriation that is made, however small, can be advantageously expended. The portion of the Fork in Kentucky has already been improved.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

D D 12.

PRELIMINARY EXAMINATION OF LICKING RIVER, KENTUCKY, FROM FARMERS TO WEST LIBERTY.

UNITED STATES ENGINEER OFFICE,
Cincinnati, January 20, 1887.

GENERAL: In accordance with the instructions contained in Department letter of September 27, 1886, I have to submit the following report of the preliminary examination of Licking River from Farmers to West Liberty, Ky.

The distance between the two points specified by the river is about 68 miles. This portion of the Licking flows through a narrow valley of fertile bottom lands which is sparsely populated. The hills and mountains adjoining are rich in coal, both bituminous and cannel, the latter being of an exceedingly fine quality.

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The present commerce upon this part of the river is estimated to have amounted to $1,130,500 for the year just ended. (See inclosed statement.) Its principal outlet is by way of the Newport News and Mississippi Valley Railroad, which crosses the river at Farmers, the lower limit of the part of the river under discussion.

In 1878 a careful survey of the upper portion of this river was made by Mr. C. Schenck, under direction of Lieut. Col. W. E. Merrill, Corps of Engineers. A detailed report of this will be found in the Annual Report of the Chief of Engineers for 1879, pages 1422 to 1437. From this report it will be seen that it is not probable that there is sufficient water in this river during a portion of the year to warrant an attempt to improve it by slackwater navigation.

The section of country drained is long and narrow, and was estimated by Mr. Schenck not to exceed 600 square miles in area, which is scarcely sufficient to maintain a slackwater system during the low-water season. Much benefit to commerce would result, however, if the snags and rocks now obstructing the channel were removed, and to this extent the portion of the river between Farmers and West Liberty is deemed worthy of improvement.

No additional survey is required. It is estimated that the improvement mentioned would cost $260 per mile, or $17,680 for the entire distance of 68 miles.

Very respectfully, your obedient servant,

JAS. C. POST,
Major of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

Commercial statistics of Licking River for year ending December 31, 1886.

Articles.	Quantity.	Average price.	Value.
Coal ..... bushels..	30,000	15 c. per bush.	$4,500
Cross-ties ..... number..	45,000	35 c. each.	15,750
Saw-logs:			
Walnut ..... do....	5,000	$10 each.	50,000
Oak ..... do....	110,000	$3.50 each.	385,000
Poplar ..... do....	220,000	$3 each.	660,000
Staves ..... do....	150,000	35 c. per 1000.	5,250
Merchandise ..... tons..	100	$100 per ton.	10,000
Total.	.....	.....	1,130,500

D D 13.

REPORT UPON THE COMMERCIAL VALUE AND IMPORTANCE OF THE WORKS OF THE GREEN AND BARREN RIVER NAVIGATION COMPANY.

PITTSBURGH, PA., *December* 21, 1886.

GENERAL: The act of Congress approved August 5, 1886, provided that—

The Secretary of War is hereby authorized and directed to ascertain the value and commercial importance of the works and property of the Green and Barren River Navigation Company, situated on the Green and Barren rivers, in the State of Kentucky; * * * and in order to acquire such information the Secretary of War shall appoint a board of three competent engineers from the Engineer Corps of the

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United States Army, which board shall * * * report to the Secretary of War, who shall report thereon to Congress at its next succeeding session; and the cost of such examination shall be paid out of the sum appropriated by this act for surveys: *Provided*, That nothing herein shall be construed as committing Congress to the purchase of the said works.

By direction of the Secretary of War a board of officers, consisting of Col. James C. Duane, Maj. William R. King, and Maj. Alexander Mackenzie, was constituted by Special Orders No. 112, Headquarters Corps of Engineers, United States Army, Washington, D. C., August 13, 1886, to consider and report upon the questions referred to in foregoing act of Congress.

By letter of the Chief of Engineers, dated October 18, 1886, Maj. Amos Stickney, Corps of Engineers, was detailed as a member of the Board, *vice* Colonel Duane, who was relieved in consequence of his appointment as Brigadier-General and Chief of Engineers, United States Army.

The matters requiring investigation having been considered and reported upon by Lieut. Col. W. E. Merrill and Maj. J. C. Post, Corps of Engineers, United States Army, and much information being collected in the engineer offices at Cincinnati, Ohio, a preliminary meeting was held there on the 22d, 23d, and 24th of September.

After organization the following instructions from the Chief of Engineers were received and considered:

It is desired that the Board avail itself of all attainable information upon the subjects upon which it is required to report, and to this end it will visit the localities; hold public meetings, giving due notice thereof through the newspapers, or otherwise as may appear best; invite discussion orally or in writing, and, in brief, use every effort to inform itself in regard to the origin of the works, respectively; the means provided for their construction, and their cost; also in reference to their present and prospective value to the interests of the commerce and navigation likely to be promoted by their acquisition and improvement by the Government, with the view of making the reports full, complete, and exhaustive, and to this end every avenue of information should be pursued to its source.

It is suggested in this connection that Lieut. Col. William E. Merrill and Capt. James C. Post, Corps of Engineers, may be able to furnish from the records of their offices valuable data in reference to the works specified in the act, and the Board is authorized to call upon them accordingly.

During the session of the Board in Cincinnati the following circular letter was prepared and distributed:

* * * * * * *

In accordance with the above provision of law, the Secretary of War has appointed a Board of Engineers, consisting of Col. James C. Duane, Maj. William R. King, and Maj. Alexander Mackenzie, to examine and report upon the Green and Barren * * * rivers.

It is the desire of this Board to collect all available information relating to the commercial importance, present and prospective, of the rivers under consideration, and such facts as may assist in forming a proper estimate of the present value of the five locks and dams on the Green and Barren rivers, built by the State of Kentucky, and now in possession of the G. and B. Navigation Company.

* * * * * * *

You are respectfully invited to submit, at your earliest convenience, any information or suggestions which, in your opinion, have any bearing on the questions before the Board.

* * * * * * *

On the 25th of September the Board met at Bowling Green, Ky., and in company with the officers of the navigation company and others went over the river from Bowling Green, Ky., to Evansville, Ind.

Through correspondence and personal interviews and from records and reports a large amount of information has been secured; but much of such information has been in the form of opinions rather than facts,

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and on some points is so indefinite as to render positive statements by the Board impracticable. In this connection it may be proper to state that the powers of the Board have only permitted requests for information, and compliance has been at the will of those from whom facts were solicited.

Having considered all the information presented, the Board has the honor to submit the following report, with appendices, upon—

The commercial importance and value of the works and property of the Green and Barren River Navigation Company, situated on the Green and Barren rivers, in the State of Kentucky.

The river and harbor act of March 3, 1879, directed a survey of "Green River and its tributaries, Muddy and Barren rivers, Kentucky." This survey was assigned to Maj. W. E. Merrill (now lieutenant-colonel), Corps of Engineers, who submitted a report under date of February 21, 1880. This report, with appendices, is printed as Senate Ex. Doc. No. 116, Forty-sixth Congress, second session. The act of July 5, 1884, provided that—

The Secretary of War is hereby directed to report to Congress at its next session, or sooner if practicable, the condition of the Green and Barren rivers * * * and the provisions and estimates of cost necessary to relieve the same from incumbrance, with a view to such legislation as will render the same free to commerce at the earliest practicable period.

This question was referred to Capt. (now Major) James C. Post, Corps of Engineers, who submitted a report under date of January 27, 1885, which is printed as House Ex. Doc. No. 212, Forty-eighth Congress, second session. A resolution of the House of Representatives of February 15, 1886, called upon the Secretary of War—

To ascertain and report at the earliest practicable period upon what terms the franchises and property of the Green and Barren River Navigation Company, in Kentucky, can be obtained and conveyed to the United States, so that said streams may be opened with their large commerce free to the people of the States.

A report upon this matter was submitted by Maj. J. C. Post, March 17, 1886, and is printed as House Ex. Doc. No. 152, Forty-ninth Congress, first session.

In the above-mentioned reports the subjects of Green and Barren River navigation and the franchise of the company which now controls its navigation under a lease from the State of Kentucky are discussed at length. The following extracts are taken from the report of Major Post:

* * * * * * *

The Green and Barren rivers lie wholly within the State of Kentucky, and with their tributaries drain an area of about 10,000 square miles, nearly all of which is contained within the State. The general direction is northwest, and the Green, after receiving the waters of the Barren River, empties into the Ohio, about 8 miles above Evansville, Ind.

About fifty years ago the State of Kentucky undertook the improvement of these rivers by locks and dams. Six locks and dams upon the Green River, and one upon the Barren, were placed under contract. Of these, four locks and dams upon the Green, and the one upon the Barren, were completed, and the slackwater system, as it now exists, was open to navigation in 1841. The two additional locks and dams upon the Green River were not constructed.

The first lock and dam on the Green River was placed at Spottsville, 8¼ miles from the Ohio; the second at Rumsey, 51¾ miles from the first; the third at Rochester, 43¼ miles from the second, and the fourth at Woodbury, 41½ miles from the third. No. 1, Barren River, is at Green Castle, 15 miles from No. 4, Green River.

These five locks and dams, together with the backwater from the Ohio, give continuous navigation for a draught of 4 feet from the Ohio River to Bowling Green, a distance of 175 miles. They are owned by the State of Kentucky, and were operated by the State until 1868.

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In 1868 the Green and Barren Navigation Company was chartered by the legislature of Kentucky, and the locks and dams were transferred to its control for a period of thirty years.

* * * * * * *

Under the arrangement made, the Green and Barren Navigation Company became the practical owners of the property belonging to the State of Kentucky, upon these rivers. This property consisted of the locks and dams, and the lands adjacent thereto, with the buildings and the water-power resulting from the dams.

* * * * * * *

The navigation of the Green and Barren rivers, as far as the slackwater system extends, is in good condition. The locks are serviceable, and are built of coursed masonry. All the land walls, which were originally built too thin, have yielded, with exception of the one at No. 4 (Woodbury), to the pressure of the earth behind them. That of the lock at Rumsey leans more than a foot, and has been tied back with iron rods to a crib sunken in the earth in its rear to prevent a continuance of the action and the wall from falling. It seems to be in a stable condition at present, but it is exceedingly doubtful how long it will remain so. A mill-race behind the land wall at Woodbury prevents it from receiving as much pressure as the others.

The lower gates of all the locks are new, and are good and substantial. The upper gates are much older, and are generally out of repair.*

All the dams are wooden, and are composed of cribs filled with stone covered with sheeting. They are apparently strong and firm, and bear evidence of recent repairs.

The abutments of Nos. 1 and 2 are of masonry, and at No. 3, Green River, and No. 1, Barren River, are natural rock bluffs. That at No. 4 is composed of wooden cribs.

* * * * * *

From a letter addressed to Lieut. Col. W. E. Merrill by General D. C. Buell, the following description is taken:

* * * * * * *

Green River is distinguished by some remarkable characteristics. It rises in the central portion of Kentucky, flows with a gradual descent in a general course a little south of west to within about 100 miles of its mouth, and thence in a northwesterly direction to the Ohio, 10 miles above Evansville. It drains a large extent of country, comparatively level or moderately hilly, and is therefore not subject to the sudden and torrent-like freshets which characterize rivers that have mountain sources. A striking feature is its great depth in the last 150 miles of its course, with only occasional obstructions from rocky reefs. In the natural pools thus formed, from 20 to 30 feet is a common depth. Another peculiarity is the subterranean character of its sources. Perhaps it is this peculiarity, combined with the great depth, that preserves a comparatively mild temperature in the water, so that the river in its lower portion is rarely obstructed by ice. The mouth of Green River has always been a noted harbor for boats of every description in the season of ice on the Ohio. Still another peculiarity for a river of its size is the considerable number of tributaries adapted to navigation of from 15 to 30 miles or more, thus extending the area of its usefulness as an avenue for commerce. Pond River, Rough Creek, Mud River, Big Barren, Bear Creek, and Nolin, respectively about 60, 80, 140, and 180 miles from its mouth, are examples of this sort. The river varies in breadth from about 200 yards at the mouth to about 100 yards at the confluence of the Big Barren. Rock foundations are found at all desirable points for locks and dams, and building materials, timber, and stone of every desirable kind are available everywhere. The banks have an average height of about 30 feet above low water, and the river is bordered by a rich bottom land, varying from about 400 yards at the Big Barren to perhaps nearly a mile at the mouth. The bottoms are often overflowed, but less frequently and to a less depth, I think, within the last twelve years than formerly. The change may be ascribed to the clearing of the land for the sake of the timber.

* * * * * * *

From the preceding extracts, and other sources, it appears—

That the Green and Barren rivers form an important line of navigation through a country rich in mineral and agricultural products. In a state of nature, these streams were, at certain stages, obstructed by rapids, which boats could not pass. About fifty years ago, the State of Kentucky most wisely improved these rivers, by constructing five locks and dams, giving continuous slackwater navigation throughout the year, from the Ohio River to Bowling Green, a distance of 175 miles.

* The upper gates have been rebuilt, and are now in good condition.

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The locks and dams were built under difficulties which increased their cost, but the work was well done. These locks were made 150 feet long and 36 feet wide, giving a capacity which it was thought would be sufficient for all future needs of commerce and navigation; but, it is now apparent that, to avoid delays and reduce cost of transportation to a minimum, larger locks will be desirable in the future.

For a number of years after completion, the locks were operated and tolls were collected by the State of Kentucky; but, in 1868, by an act of the legislature, the Green and Barren River line of navigation was leased for a period of thirty years to the Green and Barren River Navigation Company, with power to collect tolls, operate mines, run steamboats, and conduct a general business. The practical effect of this lease has been to give the exclusive right of free transportation to the company and render competition impracticable. This condition of affairs will continue till March 9, 1898, unless the rights of the company are extinguished by purchase or other legal means.

In 1880 the Kentucky legislature, in behalf of the commercial interests of the Green and Barren rivers, attempted to repeal the act which gave to the navigation company its privileges; but such action was declared illegal by the supreme court of the State, which court at the same time called attention to the fact that the State could, when the same was demanded by public necessity, resume control of the Green and Barren rivers upon the payment to the company of a just compensation.

In place of such action as was suggested by the decision of the court, the Kentucky legislature in 1886 ceded to the United States the five locks and dams on the Green and Barren rivers, upon the condition that the United States rather than the State should extinguish by "purchase or otherwise the claim of the navigation company to exact tolls and control the rivers."

Discussions upon commercial importance, value of works and property, legislation, rates of toll, etc., compiled by the Board, and letters having an important bearing on the questions under consideration, are given as appendices to this report.

Referring to such appendices for details and reasons the Board would submit the following summary and conclusions:

COMMERCIAL IMPORTANCE.

The Green River and its tributary, the Big Barren, are streams most favorably adapted to purposes of navigation, and they with their branches are the natural outlet for a country rich in mineral and agricultural wealth, and by connecting this tributary country, through the Ohio, with the markets of the Mississippi Valley, are capable of being made important navigable waters of the United States.

These rivers are at the present time, by reason of the charter granted a private corporation by the State of Kentucky, virtually closed to general commerce, and the country tributary to the rivers is placed at a great disadvantage. The tolls, which prohibit competition in transportation, and the uncertain results of any enterprise which is dependent on the will of a monopoly, prevent the investment of capital which is necessary for a full development of the country.

Considering the relative advantages of this line of navigation and the natural resources of the country, as compared with other streams and territory, it appears most probable that the improvement of the Green River and its tributaries would have been undertaken by the

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United States long ago had not the conditions been such as to withdraw these rivers from the fostering care of the General Government.

The value of existing commerce is placed at $6,000,000 per annum. The possible commerce with the rivers in a free and fully improved condition is very great, greater in fact than that of many other streams which are now being improved by Congressional appropriations at great expense.

VALUE OF EXISTING WORKS OF IMPROVEMENT.

These works, which are the property of the State of Kentucky, consist of five locks and dams. The present intrinsic value of the works is placed by the Board at $350,000, and the money value of benefits which would accrue to general commerce from a release from the control exercised by the Green and Barren River Navigation Company is considered to be not less than $30,000 per annum, which yearly saving would amount, during the remaining life of the company's lease, to an amount equal, at least, to the present intrinsic value of works.

VALUE OF PROPERTY (FRANCHISE) OF THE GREEN AND BARREN RIVER NAVIGATION COMPANY.

The company's property consists of chartered rights granted them by the State of Kentucky. In the works themselves they have no ownership. The company, while disclaiming any desire to dispose of their property, offer the same to the United States for a sum based upon its estimate of the earning capacity of the franchise. At the date of the proposition, November 26, 1886, with eleven years and four months for lease to run, the value is placed at $338,000. On the 30th of next June this value would be about $325,000.

The Green and Barren River Navigation Company is now the legal owner of this property, and, so long as a voluntary sale is under consideration, the company has an undoubted right to fix the selling price.

Considering the value of the franchise in the light of damages to the business of the company, which might follow an abrogation of the right to collect tolls, their price seem excessive, but the Board does not consider that its powers are sufficient to determine the extent of such damages.

CONCLUSION.

The Board is of the opinion that, in justice to the country tributary to the Green and Barren rivers, the present obstructive tax on its commerce should be removed, and it is also of the opinion that the commercial importance of these rivers is sufficiently great to justify the General Government in extending aid to their improvement.

There appears to be three methods by which the General Government can secure control of the Green and Barren rivers and their works of improvement.

(1) By purchasing the chartered rights on the most reasonable terms the Green and Barren River Navigation Company will accept, as provided for by the act of the Kentucky legislature.

(2) By condemnation, with just compensation, as determined by the proper legal tribunal. This method is also contemplated by the act of the Kentucky legislature, which cedes the works to the United States on condition that the claims of the company are extinguished by purchase or otherwise.

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(3) By accepting the works and assuming control of the improvements of the Green and Barren rivers, on the condition that the State of Kentucky will first extinguish the franchise, as suggested by the State court of appeals. On such a basis, the Board is of the opinion that the interests involved are sufficient to justify the General Government in re-imbursing the State in an amount not exceeding $350,000, the estimated present intrinsic value of the works.

Respectfully submitted.

W. R. KING,
Major of Engineers.
AMOS STICKNEY,
Major of Engineers.
A. MACKENZIE,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

APPENDICES.*

1. Letter of General Duane to C. G. Smallhouse, president of the Navigation Company, requesting information.—Reply of Mr. Smallhouse, November 26, 1886.—Three letters of Mr. Smallhouse to Captain Post, dated November 27, 1884, January 2, 1885, March 8, 1886, touching the value of the company's franchise and the commercial importance of the rivers.—Letter of General D. C. Buell, November 18, 1886, in regard to commercial importance of the Green and Barren rivers, and value of the company's franchise.—Letter of Captain A. H. Edwards, of Evansville, Ind., October 30, 1886, on commercial importance of the Green and Barren rivers, and condition of the works under State and company management.
2. Commercial importance of the works of improvement on Green and Barren rivers.
3. Value of franchise of the Green and Barren River Navigation Company.
4. Cost of locks and dams on Green and Barren rivers, and present values to the United States.
5. Legislation, etc., concerning Green and Barren River Navigation Company.
6. Rates of toll and resulting tax on commerce.

* Omitted. Printed in House Ex. Doc. No. 111, Forty-ninth Congress, second session.

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APPENDIX E E.

IMPROVEMENT OF GREAT KANAWHA AND ELK RIVERS, WEST VIRGINIA, AND OF NEW RIVER, IN VIRGINIA AND WEST VIRGINIA.

REPORT OF COLONEL WM. P. CRAIGHILL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Great Kanawha River, West Virginia.
2. Elk River, West Virginia.
3. New River from the mouth of Wilson, in Grayson County, Virginia, to the mouth of Greenbrier River, West Virginia.

EXAMINATION.

4. Coal River, West Virginia.

(For letter of transmittal, see Appendix I).

E E 1.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

The object of the improvement has been to give a depth of not less than 6 feet all the year round throughout the whole river, 96 miles.

The means are locks and dams. The locks are about 350 by 50 feet. The following table shows the present condition:

No.	Distance from Charleston.	Style of dam.	Remarks.
2	26½ miles above	Fixed	Lock very nearly completed; dam under contract.
3	21 miles above	do	In operation.
4	15 miles above	Movable	Do.
5	9 miles above	do	Do.
6	4 miles below	do	Lock and dam completed and in operation.

One more site may be occupied above and several more below, but the portion of the river (about one-third) on which work is now complete or in progress, is that which needed it most. Some dredging is also required in the pools as well as the removal of snags and rocks.

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If there had been an appropriation at the session of Congress, 1884–'85, the completion of Dam 2 would have been assured in 1885, a very important step in the improvement. The appropriation of 1886 was made too late to commence Dam 2 in 1886. Its completion in 1887 is expected with the exhaustion of the appropriation of 1886.

But for the failure of the appropriation bill of 1886–'87, Lock 7 could have been commenced and been now well forward.

The site is already owned by the United States. The sites below have yet to be procured, but the authority of Congress is needed. After the giving of such authority, the best method has been by purchase or by condemnation under existing State laws.

Mr. A. M. Scott has continued to exercise the local charge in his usual efficient manner.

His report, which is appended, treats in detail of the operations of the year.

The United States land at Site 6, abutment side, was for more than three years crossed without proper authority by the track of the Ohio Central Railroad Company, which extends from Charleston along the right bank of the Kanawha River to its mouth. The crossing was authorized by Congress by act approved February 28, 1887.

As the improvement of the river has progressed the commerce on it, notably the shipment of coal, has greatly increased. This has not been to the disadvantage of the Chesapeake and Ohio Railroad, as some supposed would be the case.

The telephone line has been maintained between the central office in Charleston and the locks, and is used by night as well as by day, being found indispensable for the proper oversight and direction of operations as well of construction as of maintenance.

A guage reader has been kept at Kanawha Falls, near which place the Gauley joins the New to form the Great Kanawha River; and another at Hinton, where the Greenbrier empties into the New River. The compensation of these men is less then $10 a month each. They send to the central office daily reports by postal card of the stage of the river at their respective stations, and by telegraph when there is a rapid rise. These reports are necessary as warnings to the central office in Charleston in order that such maneuvers of dams, etc., may be had in time as the height and duration of the freshets may require.

For perfect security a similar station should be occupied at some point on the Upper Gauley, and perhaps also on the Elk.

Money statement.

July 1, 1886, amount available		$43,373.47
Amount appropriated by act approved August 5, 1886		187,500.00
		230,873.47
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$103,691.33	
July 1, 1887, outstanding liabilities	24,854.33	
		128,545.66
July 1, 1887, amount available		102,327.81

Amount (estimated) required for completion of existing project..... 1,670,000.00

Amount that can be profitably expended in fiscal year ending June 30, 1889..... 500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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OPERATING AND KEEPING IN REPAIR THE LOCKS AND DAMS ON THE GREAT KANAWHA RIVER, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., July 19, 1887.

GENERAL: During the past fiscal year the expense of operating the locks and dams on the Great Kanawha River in West Virginia has been paid in the manner indicated by section 4, act of July 5, 1884.

In compliance with the proviso to that section which requires the rendition of an itemized statement of such expenses, I have the honor to forward the inclosed paper.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Statement of amount expended during the fiscal year ending June 30, 1887, *out of the general appropriation for "operating and care of canals and other works of navigation" in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.*

Lock and Dam No. 3:		
For wages of regular lock hands	$1,980.00	
For repairs and extra labor	1,133.00	
For supplies, as oils, fuel, tools, etc	76.91	
For freights and transportation	11.10	
		$3,201.01
Lock and Dam No. 4:		
For wages of regular lock hands	1,971.67	
For repairs and extra labor	411.98	
For supplies, as oils, fuel, tools, etc	103.82	
For freights and transportation	5.35	
		2,492.82
Lock and Dam No. 5:		
For wages of regular lock hands	1,980.00	
For repairs and extra labor	772.12	
For supplies, as oils, fuel, tools, etc	178.27	
For freights and transportation	9.45	
		2,939.84
Lock and Dam No. 6, after October 11:		
For wages of regular lock hands	1,205.83	
For repairs and extra labor	87.80	
For supplies, as oils, fuel, tools, etc	251.24	
For freights and transportation	1.85	
		1,546.72
Telephone:		
For pay of rent	99.99	
For repairs	120.17	
For freights and transportation	7.99	
		228.15
Gauge-keepers:		
For pay of gauge-keepers and reporters at Hinton and Kanawha Falls		150.12
Steamer Bee:		
For part of running expenses of steamboat		790.43
Total		$11,349.09

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Abstract of proposals for furnishing telephone poles for Great Kanawha River, opened at Charleston, Kanawha County, W. Va., at 12.05 p. m., July 7, 1886.

No.	Name and address of bidder.	Price.
1	Thomas W. Farley, Kanawha Falls	$0.75

Contract with Thomas W. Farley.

Abstract of proposals for completing the No. 6 lock house, opened at the United States Engineer office, Charleston, W. Va., at noon, August 28, 1886.

No.	Name and address of bidder.	Amount.
1	Hennemann Bros., Charleston, W. Va	$925.00
2	Henry Crawford, Saint Albans, W. Va	735 00
3	David Eagan, Charleston, W. Va	771.55

Contract with Henry Crawford.

Abstract of proposals for building dam and abutment of Lock No. 2, Great Kanawha River improvement, opened at 12.05 p. m. September 24, 1886.

	Estimated Quantities.	1. Lewis M. Petitdidier, Cincinnati, Ohio.		2. Water and Gas Works Construction Company, Pittsburgh, Pa.		3. McMahon & Walton, Wytheville, Va.	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
Grubbing and clearing, complete	.....	.....	$1,500	.....	$300	.....	$360.00
Excavation....per cubic yard..	38,000	$0.75	28,500	$1.00	38,000	$0.88	33,440.00
Rock excavation.....do....	100	1.50	150	3.00	300	4.00	400.00
Embankment, in place...do....	6,000	.35	2,100	.65	3,900	.50	3,000.00
Puddling, in place.....do....	1,000	1.00	1,000	1.25	1,250	1.25	1,250.00
Stone filling, in place ....do....	16,000	1.55	24,800	1.75	28,000	1.70	27,200.00
Hand-placed riprap, in place, per cubic yard	550	2.50	1,375	4.00	2,200	3.00	1,650.00
Paving, in place, per cubic yard.	630	4.00	2,520	6.50	4,095	4.00	2,520.00
Rock-faced masonry, in place, per cubic yard	950	9.50	9,025	12.00	11,400	10.25	9,737.50
Coping masonry, in place, per cubic yard	32	16.00	512	25.00	800	25.00	800.00
Timber, in place, per 1,000 feet B. M	1,070,000	30.00	32,100	39.50	42,265	39.95	42,746.50
Iron, in place..... per pound..	51,000	.05	2,550	.10	5,100	.05	2,550.00
Total.....	.....	.....	106,132	.....	137,610	.....	125,594.00

	4. C. J. McDonald, Pittsburgh, Pa.		5. Frank Hefright, Huntingdon, Pa.		6. Charles H. Strong & Son, Cleveland, Ohio.	
	Price.	Amount.	Price.	Amount.	Price.	Amount.
Grubbing and clearing, complete	.....	$42.50	.....	$500	.....	$200
Excavation..... per cubic yard..	$0.85	32,300.00	$0.60	22,800	$0.60	22,800
Rock excavation .....do....	2.50	250.00	2.00	200	2.50	250
Embankment, in place .....do....	.50	3,000.00	.50	3,000	.40	2,400
Puddling, in place .....do....	.75	750.00	1.00	1,000	1.50	1,500
Stone filling, in place.....do....	1.75	28,000.00	1.50	24,000	1.75	28,000
Hand-placed riprap, in place.....do....	2.25	1,237.50	5.00	2,750	4.00	2,200
Paving, in place.....do....	4.50	2,835.00	6.00	3,780	5.00	3,150
Rock-faced masonry, in place.....do....	12.50	11,875.00	10.00	9,500	8.50	8,075
Coping masonry, in place.....do....	17.50	560.00	25.00	800	20.00	640
Timber, in place .....per 1,000 feet, B. M..	35.00	37,450.00	50.00	53,500	39.00	41,730
Iron, in place .....per pound..	.05	2,550.00	.10	5,100	.05	2,550
Total	.....	120,850.00	.....	126,930	.....	113,495

Contract with Lewis M. Petitdidier.

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Abstract of proposals for building a crane-boat for the Great Kanawha River improvement, opened at 12 m. February 18, 1887.

No.	Name and address of bidder.	Price.
1	J. E. Thayar, Charleston, Kanawha County, W. Va	$575.00
2	James Snyder, Charleston, Kanawha County, W. Va	640.75
3	Layten and F. C. Williams, Malden, Kanawha County, W. Va	449.50

Contract with Layten and F. C. Williams.

Abstract of proposals for building a fuel-boat for dredge for the Great Kanawha River improvement, opened at the United States Engineer office at Charleston, W. Va., at 12 m. March 1, 1887.

No.	Name and address of bidder.	Price.
1	J. E. Thayer, Charleston, Kanawha County, W. Va	$350.00
2	Layten Williams, Malden, Kanawha County, W. Va	455.00
3	James Snyder, Charleston, Kanawha County, W. Va	470.90

Contract with J. E. Thayer.

Abstract of proposals for building a dump-boat for Great Kanawha River improvement, opened at the United States Engineer office at Charleston, W. Va., at 12 m. May 31, 1887.

No.	Name and address of bidder.	Amount.
1	Job E. Thayer, Charleston, Kanawha County, W. Va	$1,450
2	W. D. Lewis, Malden, Kanawha County, W. Va	1,374
3	Layten Williams, Malden, Kanawha County, W. Va	1,430

Contract not awarded for want of available funds.

REPORT OF MR. ADDISON M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston, W. Va., July 1, 1887.

COLONEL: I have the honor to submit the following report on the improvement of the Great Kanawha River for the fiscal year ending June 30, 1887.

LOCK NO. 2.—FOR STATIONARY DAM.

[84½ miles from the mouth of the river; 26½ miles above Charleston.]

The contractors for "finishing Lock No. 2," embracing the remainder of the masonry, timber-work (not including the lock-gates), earth-work, etc. (reference for further description may be made to Report of the Chief of Engineers for 1886, vol. III, pages 1594 and 1595), are just about completing their contract. The last of the coping will be set to-morrow. A few days more will be required to place the dowels in coping, finish the paving back of land-wall, etc., and remove rubbish.

This lock is 308 feet long between quoins (377 between faces of wings) and 50 feet wide at level of miter-sills. The top of coping is 31 feet above lower miter-sill and

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fom 37 to 39 feet above foundation. The foundation is rock, found from 12½ to 14½ feet below extreme low-water mark. The maximum lift will be 12 feet.

The following is a summary of the principal items of material and work entering into the permanent construction of this lock (work and materials of coffer-dams, etc., not included), embraced by the contracts of Mr. Frank Hefright and C. H. Strong & Son.

Cement-mortared masonry of all classes	cubic yards..	16,615
Paving, riprap, and stone filling	do....	5,218
Earth excavation	do....	31,790
Rock excavation	do....	1,326
Embankment and puddling	do....	17,495
Square oak timber	1,000 feet, B. M..	137,128

CONTRACT FOR DAM, ETC.

A contract for building the timber dam, masonry abutment, abutment cribs, and shore protection at Lock No. 2 was entered into with Louis M. Petitdidier, by agreement approved November 9, 1886.

The dam is to be stationary, built of timber cribs sunk to rock and filled with stone. Length of dam, 524 feet; height from foundation, about 26 feet. The face, from a little above low water, will be built in steps. Width at foundation and up to first apron, 38 feet. The back will be vertical to within 3 feet of top and have a short slope to crest.

The dam, abutment and abutment cribs are all to rest on solid rock foundation, found here from 12 to 14½ feet below extreme low-water mark.

The following is an approximate summary of the quantities embraced by the contract:

White-oak timber	1,000 feet, B. M..	1,070,000
Stone filling, riprap, and paving	cubic yards..	17,000
Cement mortared masonry	do.....	980
Excavation	do.....	38,000
Embankment and puddling	do.....	7,000
Iron	pounds..	51,000

It was too late to begin work in the river last season after the contract was let. The contractor arrived on the ground November 17, and spent considerable time during the fall and winter making arrangements for material, machinery, buildings, etc. The excavation for the abutment and protection cribs was begun in March. The principal work done up to this time has been on excavation, and preparation and delivery of timber and stone. Up to the present time he has excavated about 22,000 cubic yards of earth and gravel. The excavation of the abutment reached solid rock June 29, and the laying of masonry was commenced the next day.

A dredge has been at work, excavating for the dam next to the lock, since June 9, and has removed, altogether, about 2,200 cubic yards. With this exception all the "excavation" mentioned above, as done, was taken out by hand, i. e., with steam-hoisters, carts, barrows, etc., at the abutment end.

The contractor has now about 360,000 feet, B. M., of square oak timber out, either sawed or hewn. About 190,000 feet of this is at the site and mostly framed ready to be placed. His quarry is producing well and he has a good deal of stone out.

LOCK-GATES, HEAD BAY, TRESTLE DAM, ETC., AT NO. 2.

The material for the lock-gates is to be procured by contract, but the gates built and hung as at the other locks (except No. 5) by hired labor.

The proposals for the "irons for the lock-gates and for maneuvering the filling valves, and for the trestle dam across the head of the lock" were opened July 1, and you are now advertising for the timber for the lock-gates, the proposals to be opened July 28.

LOCK NO. 3.—STATIONARY DAM.

[21 miles above Charleston.]

Locking was suspended at No. 3, twenty-one days during the year, five days by high water, and sixteen by the getting out of order and repair of the filling valves.

Repairs on valves.—The repairs were made necessary by displacement of the cast frames of the pitman cranks in the bottom of the wells due to giving way of some of the wedge bolts.

Coffer-dams were built across the head and foot of the lock and the water taken from the chamber with a steam-pump. New bolts were put in the crank supports,

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additional bolts and straps placed, and the apparatus generally overhauled and strengthened. The occasion was also improved to overcome, as far as practicable, the leakage about the valves and head bay which, as you are informed, has always caused trouble at this lock.

Since the repairs the lock has worked quicker and easier than ever before. The time required to make a lockage was reduced, mainly by the reduction of leakage about the valves, about one-third.

The total cost of the repairs to the valves and apparatus, not including the work of the regular employés, was $781.36.

Riprapping.—The banks below this work have suffered but little from scour during the year. About 740 cubic yards more riprap were placed during the fall. The cost of the riprapping, not including labor of lock hands, was about $350.

LOCK NO. 4.—MOVABLE DAM.

[16 miles above Charleston.]

The dam has been up one hundred and thirty-eight days during the year. It was put up three times and lowered twice. It was put up July 26, and remained standing until November 24, when it was thrown for a rise; at this lowering fifteen pass wickets had to be thrown by hand, but the entire dam was let down by five men in two and a half hours.

The dam remained down from November 24, till May 30, (the stage of water during the time making it unnecessary to raise), when the dam was closed. It was thrown again for a rise in the river June 3. In this maneuver the lock-tripper broke between the eighth and ninth wicket from wall (at a place where it had frequently been bent), but everything was securely lowered. A good stage of water made it unnecessary to raise the dam again until June 16. The dam was closed on the 18th and is still up. After lowering June 3, the lock-bar was taken out and the long outer end attached to the gearing rack, leaving eight of the end wickets on this section, to be thrown by hand. Our experience proves there would be no difficulty in regularly operating at least half of the pass wickets in this way, *i. e.*, the channoine hurters without the tripping-bar.

Repairs.—In addition to the ordinary repairs about the works, on apparatus, boats, tools, buildings, etc., about 145 cubic yards of riprap were quarried and placed last fall at a threatening place on the abutment bank.

The following is a summary of the records of No. 4 for the year:

Through the lock:		
Steamers		765
Coal-barges		304
Other craft		24
Coal	bushels..	870,800
Total lockages made		849
Through Navigation Pass:		
Steamers		1,686
Coal-barges		1,258
Other craft		36
Coal	bushels..	5,619,500
Rain-fall	inches..	42.76

LOCK NO. 5.—MOVABLE DAM.

[9 miles above Charleston.]

The dam has been up one hundred and forty-one days. It has been raised twice and lowered once during the year. It was closed July 24, and remained up till thrown for the rise of November 24. At this lowering two wickets on the bar and one on the Pasquean section failed to fall and were let down by hand. Everything was put down by five men in two hours and ten minutes. The dam remained down down till June 16, when it was closed and has since been up.

Protection of banks, etc.—The riprap protection below the lock was extended downstream last fall 130 feet farther than before. The land crib below the lock was also raised about 2½ feet higher, filled with stone, and the top paved. Some more riprap was also placed on the abutment side above the dam. About 640 cubic yards of stone altogether were used for this, the most of which was quarried and hauled.

The cost of this stone and crib work, not including work of regular hands, was about $650.

Repairs to wicket-horses, etc.—This season, before the dam was raised, a number of the wicket-horses of the pass were taken out and repaired. They were mostly bent

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near the bottom where they strike the sill. They were straightened and strengthened at the weak place with an oak piece attached with clevises.

The following is from the records kept at the lock during the year:

Through the lock:		
Steamers		1,007
Coal-barges		735
Other craft		35
Coal	bushels..	2,698,600
Total lockages made		1,097
Through the Navigation Pass:		
Steamers		2,056
Coal-barges		2,464
Other craft		48
Coal	bushels..	10,932,000
Rain-fall	inches..	40.60

LOCK NO. 6.—MOVABLE DAM.

[4 miles below Charleston and 54 from the mouth of the river.]

This work was completed and put in operation October 11. Harrold & McDonald finished their contract for the foundations and masonry of the dam October 1, The lock-gates and wickets of the dam were completed and hung, and the trestles, etc., of the service bridge placed by hired labor. The wickets of the dam were all righted and the pool began to fill on the evening of October 5.

The lock.—The lock, with the exception of the gates, was completed in 1883. It is 342 feet long between hollow quoins and 55 feet wide at level of miter-sills. It is built of masonry, resting on solid rock found from 10.3 to 21.8 feet below low-water mark. The walls are from about 27 to 38½ feet high, according to depth to rock. The coping is level throughout at a height of 21.75 feet above miter-sills. This lock contains 11,536 cubic yards of cement mortar masonry.

This lock was planned (it was built larger than first planned—42 feet longer and 5 feet wider), under your direction, by Capt. Thomas Turtle, Corps of Engineers, in 1880. It was begun in the spring of 1881, and completed in November, 1883. The contractors were William H. Black and George Harris, of Pennsylvania.

The dam.—The foundations of the dam were not commenced till the fall of 1884, the work being delayed about two years by lack of funds.

A general description of the dam, particularly of the foundations and masonry, was given in your annual report for 1884 (Report of Chief of Engineers, 1884, Vol. 2, page 933).

The general features are the same as the other Chanoine dams (Nos. 4 and 5) completed on this river in 1880, with such modifications as experience suggested. The foundations and fixed parts were considerably improved, the main points of which are described in the report just referred to. The movable parts were also modified or strengthened to a considerable extent. Pasquean hurters were used on the pass instead of tripping bars, their experimental working at No.. 5 having shown them to be, all considered, a decided improvement. For the foot bridge, instead of movable planks an iron one, made of light aprons attached to and raised and lowered with the trestles, was adopted.

No. 6 Pool.—The pool formed by this dam is a remarkably fine one. It is over 13 miles long, and, owing to its situation and the fact that there is good holding water almost everywhere along its shores, it is certain to become an extensive coal harbor; it is already assuming importance in this way, the coal mined in the upper river being, to a considerable extent, dropped down and held in the No. 6, or "Charleston Pool."

At some of the coal tipples in the pool, particularly about the extensive works at Campbell's Creek, where there was not water enough in low stages to hold even light-loaded boats, there is now ample depth for full-loaded ones, a matter of importance to all connected with the coal business, as it enables the works to be run at times during the summer when they would otherwise be idle.

The dam raises the water at the site 11 feet above extreme low water of 1881. The greatest "lift" last fall, after the completion of the work, was 10.40 feet. The maximum lift, after No. 7 is built, will be 8.25 feet. The pool level at Charleston is 4.65 feet above low water of 1881. The dam will raise the surface, in low stages of the river, about 4 feet at Lock No. 5. The sill of No. 5 is 6.50 feet below the level of No. 6 Dam; from observations last fall it is thought the slope in extreme low stages will be about 0.25 or the minimum depth on No. 5 sill about 6.75 feet.

Operations at lock and dam since completion.—The dam, as stated, was closed October 5, 1886, and the work considered complete and in operation from October 11. The dam has been up 74 days since that date. It was thrown for a rise November 24. This first maneuver was very satisfactory. Though it was the first practice of the men together, the whole dam was let down by the four regular hands in 2 hours and 45 min-

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utes. The dam remained down till May 30, 1887, when it was entirely put up by 4 men in 11¼ hours. Thrown June 9 by 6 men in 2 hours and 40 minutes; several of the weir wickets could not be lowered on account of drift, but were put down, uninjured, the next day. The dam was entirely raised again June 16 by 5 men in 9 hours and 40 minutes, and has since been standing.

The following is from the records kept at the lock since October 11:

Through the lock:		
Coal	bushels..	2,760,700
Coal-barges		581
Steamers		348
Other craft		25
Railroad ties		3,100
Saw logs		1,481
Tan bark	cords..	805
Total lockages made		456
Through navigation pass:		
Coal	bushels..	14,368,000
Coal-barges		2,958
Steamers		1,705
Other craft		43
Railroad ties		54,453
Saw logs		3,450
Staves		520,000
Tan bark	cords..	1,150
Sawed lumber	1,000 feet, B. M..	486,000

CONTRACTS FOR SUPPLIES, BOATS, ETC.

Irons for the weir of Dam 6.—The contractors for the weir irons and the maneuvering-winch for the dam, Ainslie, Cochran & Co., of Louisville, completed and shipped the last of their work August 26, 1886. Owing to low water some of the trestles and bridge-aprons were delayed on the way and the last was not received till September 23; this occasioned no delay, however, at the dam.

Chains for Dam 6.—The contract for the chains and clevises for the wickets and trestles was awarded to the West Lebanon Rolling Mill Company, of Pennsylvania, by agreement with you, approved July 14. They had difficulty at first in making chains to stand our tests, but finally succeeded and produced a good lot of chain. The clevises were not so satisfactory, not conforming to requirements in form and finish, and were remodeled, after arrival here, at the contractor's expense.

The contract was completed in September.

Completion of No. 6 *Lock-house.*—Your agreement with Henry Crawford, the lowest bidder for this work, was approved by the Chief of Engineers September 16, 1886. The work was completed and accepted in November.

Service boat.—A contract for the hull of a service boat for No. 6 was made with the lowest bidder, Woodford White, by agreement dated July 8, 1886. The boat, as far as contemplated by the contract, was completed July 28. The boat was afterwards fitted up at the lock with a derrick, cabin, capstans, etc., by purchase in open market and hired labor.

Telephone poles.—A contract for furnishing and delivering telephone poles for a new line on the left bank of the river, between Loup Creek Shoal and Kanawha Falls, was made with Thomas W. Farley by agreement dated July 24, 1886. The poles were all delivered and accepted early in August. They were set and the wire transferred to them, from the Chesapeake and Ohio telegraph poles, by hired labor.

Fuel boat.—A fuel boat for use with the dredge and tow-boat was built by contract with J. E. Thayer in April and May. Your agreement with the contractor was approved April 4, 1887, and the boat was completed May 28.

Crane boat.—A crane boat for removing obstructions and general use on the river was built under contract with Layten and F. C. Williams entered into March 1, 1887. The boat was completed and delivered June 21.

Dump boat.—Proposals for building a dump-boat for use with the dredge were called for by your advertisement dated April 4, 1887, and again by advertisement of May 10. The building of the boat this season was finally abandoned, it being thought advisable to wait until more funds were at hand.

DREDGING, REMOVING OBSTRUCTIONS, ETC.

Owing to the necessity of saving the money for other work the dredge has only been employed part of the working season. It was at work at No. 5, mostly on lower lock approach, from August 27, 1886, to September 11. From September 13 to October 16 the dredge and tow-boat were engaged at Lock 2, deepening the lower approach and tearing out part of the old lock coffer-dam. From October 16, 1886, until No-

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vember 6 the boats or their crews were employed at Lock No. 3, dredging and assisting in the repairs of the valves. From November 8 until December 5 work with the dredge and tow-boat was mainly at widening the head of Tyler Chute, or the lower approach to the lock and navigation pass at No. 6. Operations were suspended for winter December 5, 1886.

This spring (1887) the dredge and tow-boat were both put on the docks and calked, and their hulls generally repaired. Dredging was begun May 16; from this until June 14 the operations were directed to finishing the work at the head of Tyler, and tearing out sunken barges. Five barges that were more or less obstructions to navigation, embracing all but one advertised by your notice of September 18, 1886, were either entirely removed or torn out low enough to be out of the way of loaded boats in low stages. The dredge and tow-boat were laid up and the crews discharged, in compliance with your instructions, on June 15, 1887.

Crane-boat work.—Considerable complaint having been made about the snags, etc., that had accumulated in the river (none were removed in 1885), a party of nine men under direction of a tow-boat pilot, was employed with a crane boat sixteen days in October, 1886, removing snags, trees, rocks, etc., and repairing chute walls between Lock 6 and the mouth of the river.

Mr. Thos. E. Jeffries, assistant engineer, has been employed regularly during the year. Up to the completion of Lock and Dam No. 6 he was engaged, mainly, on that work, and since then on general office and field duty.

Mr. E. H. Kirlin continued to act as inspector at No. 6 up to the completion of the lock and dam.

Mr. T. Schoonmaker has remained at Lock No. 2 as assistant engineer and inspector, and Mr. J. H. Minnick was employed again there during the working season last year, especially to look after masonry.

Mr. Wm. M. Peyton has continued to attend to the clerical work of the office; he also looks after the property connected with the improvement. Mr. S. B. Miller, civil engineer, has been employed a considerable part of the time during the year on drawings and general office work.

The valuable assistance of all these gentlemen is cheerfully acknowledged. I also beg leave to refer to the faithful service of the lock-keepers and lockmen employed on the river at the several finished works.

Very respectfully, your obedient servant,

ADDISON M. SCOTT,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers.

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston, Kanawha County, W. Va., August 30, 1887.

Coal shipped from mines on the Great Kanawha River below Kanawha Falls, and other statistics relating to the coal business for the several years named.

Year.	Shipments by river.	Shipments by railroad.	Total shipment.	Mines in operation.	Tow-boats in use.	Coal-barges in use.
	Bushels.	*Bushels.*	*Bushels.*	*No.*	*No.*	*No.*
1875	4,048,300	*5,792,925	9,841,225	8	5	†150
1876	5,024,050	*6,609,650	11,633,700	10	5	.....
1877	5,183,650	*7,758,800	12,942,450	10	5	.....
Year ending June 30, 1881	9,628,696	6,631,660	16,260,356	13	6	.....
Year ending June 1, 1883	15,376,458	13,290,255	28,666,713	26	14	430
Year ending June 1, 1884	18,421,084	12,059,172	30,480,256	28	14	.....
Year ending June 1, 1885	17,812,323	12,972,217	30,784,540	32	22	.....
Year ending June 1, 1886	17,861,613	13,953,745	31,815,358	36	24	854
Year ending June 1, 1887	23,233,374	19,160,896	42,394,270	37	.....	.....

* The shipments by railroad for the first three years given, viz, 1875, 1876, 1877, include the New River mines above Kanawha Falls.
†About.

Respectfully submitted.

A. M. SCOTT,
Assistant Engineer.

Col. WM. P. CRAIGHILL,
Corps of Engineers U. S. A.

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EXTRACT FROM A REPORT ON THE "COMMERCIAL VALUE OF THE IMPROVEMENT OF THE GREAT KANAWHA RIVER," MADE TO COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, BY MR. A. M. SCOTT, RESIDENT ENGINEER, JANUARY 25, 1886.

In connection with the table showing the coal business the following explanation is given to show more clearly the decided effect on commerce of the locks and dams already built. In 1880, when the first locks and dams (Nos. 4 and 5) were completed, there were but two mines worthy of notice above the present site of No. 5 shipping by river, and they were doing but little, shipping altogether not to exceed 200,000 bushels per year. There are now eighteen mines above No. 5 shipping by river. The output of these eighteen mines by river for the last year was nearly or quite 12,000,000 bushels (11,905,055), as shown by our records.

From this it appears that almost all of the increase in the shipments by river shown by the table (from 5,183,650 bushels in 1877 to 17,861,613 bushels in 1885) comes from the improved part of the river.

* * * * * * *

Above the present site of Lock No. 3 (Paint Creek) there had been some attempts to ship coal by river, but this had been entirely abandoned, owing to the risks and uncertainties of navigation, before the slackwater improvement began. There are now six mines shipping by river above No. 3. Above Lock No. 2 there are at least eleven additional mines now in operation, shipping only by railroad that will begin by river as soon as No. 2 is finished. Some of these operators have already built tipples at the river in anticipation of the completion of this lock and dam.

* * * * * * *

THE EFFECT OF THE WORK THUS FAR EXECUTED ON THE RATES OF FREIGHT.

Towing rates.—The rates for towing coal from the Great Kanawha River have been materially lowered within the last few years, and, although the locks and dams have contributed materially to bring about this reduction, they cannot be regarded as the direct cause of it.

Above No. 5, as already shown, there was but little coal shipped before the locks were built, and the rates of towing, so far as any comparison with former prices is concerned, can only be taken from the Charleston pool. The present rate from Charleston pool to Cincinnati may fairly be taken at 1 cent per bushel (25 cents per ton), which includes the return of the empty barges. This is a reduction of about one-third, or from 1½ cents per bushel (37½ cents per ton), within the last five or six years. The rates to Louisville and other points on the Ohio have been correspondingly reduced.

The direct cause of this reduction in towing rates is the increased number and competition among tow-boats, but the locks and dams have no doubt contributed materially to bring about the competition by increasing the output of coal and encouraging the building and purchase of tow-boats.

THE EFFECT ON COMPETING ROUTES OF TRANSPORTATION.

The only competing route above Charleston is the Chesapeake and Ohio (now the Newport News and Mississippi Valley Company) Railroad, and although the locks and dams in the upper river have no doubt had controlling effect on local rates, the results in this have not been important. The local freight is carried almost entirely by boats.

Not considering the checking or controlling effect of river navigation on railroads, which in the case of the Great Kanawha (particularly in connection with the Ohio River) is of the greatest importance, it may almost be said, in a narrow sense, that the completed improvement of the Great Kanawha will not directly affect the freight charges by rail, from the fact that the railroads do not and never can compete with the river in carrying freight. This is particularly true in reference to the main interest of the valley, namely, coal. The rates for towing by river are so much below what it is possible for the railroads to carry that the coal business of the roads is necessarily confined almost entirely to inland points.

RATES BY RAIL AND RIVER.

In this connection a comparison of the rates on coal by rail and river will be interesting.

By river.—The distance from Charleston to Cincinnati by river is 263 miles. The charge for towing to Cincinnati, as stated before, is 1 cent per bushel, or 25 cents for 2,000 pounds. This covers the return of the empty barge. Operators who hire barges pay about a half a cent a bushel barge rent. The total additional expense,

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including the care of barges, pumping, wharfage, lines, etc., may be taken at a quarter of a cent a bushel, making a total charge to Cincinnati of 1¼ cents per bushel, or 43¾ cents per ton of 2,000 pounds. (This is very nearly one-sixth of a cent per ton per mile. For longer distances, to points on the Ohio and Mississippi below Cincinnati, the rates per mile are much less than this.) This rate, it will be noticed, is for operators who hire everything, and includes, of course, a profit on barges and towing. For operators who own their own barges and tow-boats, as several of the largest shippers do, the total cost, including wear and tear, of taking a ton of coal to Cincinnati is estimated at about 28 cents per ton, This, it will also be remembered, embraces 58 miles of the present inferior and expensive navigation (as compared with the proposed slackwater) in the Great Kanawha.

By railroad.—The rate on coal to Kanawha operators during the past season, to Winchester, Ky., and other points on the Kentucky Central Railroad between Winchester and Covington, has been $2.70 per ton of 2,000 pounds. To Covington $2. The distance from Charleston to Winchester is 171 miles, to Covington 266 miles.

The rate to Lexington, Ky. (190 miles), when the Chesapeake and Ohio comes in competition with the Cincinnati Southern, is $1.82 for 2,000 pounds.

PROSPECTIVE ADVANTAGES TO COMMERCE AND BENEFIT TO THE COMMUNITY BY COMPLETION OF THE PROPOSED IMPROVEMENT.

The advantages to result from the completion of the slackwater improvement, not alone to the Kanawha Valley but to the entire region of the Lower Ohio and Mississippi, in the interest of cheap coal are obvious and of great importance. A brief presentation of two leading facts will make this plain:

(1) It will increase materially, nearly doubling the time when coal can be shipped.

The following is compiled from daily gauge records kept at Charleston and Point Pleasant (the mouth of the Great Kanawha) under your direction. It shows the number of days in each year that there was 6 feet or more water for navigation from Charleston down and from Point Pleasant down, the Charleston gauge reading the available water for navigation in the Kanawha below, that at Point Pleasant the available water in the Ohio below:

Year.	Days Charleston gauge read 6 feet or more.	Days Point Pleasant gauge read 6 feet or more.	Year.	Days Charleston gauge read 6 feet or more.	Days Point Pleasant gauge read 6 feet or more.
1879	164	235	1885*	82	231
1880	94	207	1886	164	287
1881	126	215			
1882	184	271	Average	136	248½
1883	138	294			

* The record was not kept at Point Pleasant during part of 1884.

This shows that there are on the average considerably over one hundred days more during the year when coal can be shipped down the Ohio from Point Pleasant by open navigation than from the Great Kanawha. It also shows the shipping season to be much more uniform on this part of the Ohio than on the Kanawha.

(2) The completed slackwater improvement will practically put the Kanawha coalfield much nearer market. Owing to the narrowness (compared with the Lower Ohio) of the Great Kanawha and the contour and character of the stream, the coal tows are never more than one-third the size of those taken in the Ohio from Point Pleasant down. Up to about 7½ feet, or "dug chute" stages, in the Kanawha the tows consist of about 4 barges. On a corresponding stage in the Ohio 12 barges would be taken from the Point. Above 7½ feet, or on bar stages, the tow-boats in the Kanawha usually take from 6 to 8 barges from the Charleston pool, while the same towboat, on a corresponding Ohio stage, will easily take from 18 to 24 from Point Pleasant. The consequence is it always takes three full days, and often more, from the time a rise begins, provided the rise lasts so long, to get a tow ready to start from the mouth of the river. It very often happens, too, that the Kanawha rise will "run out" before the tow is made up.

This "doubling" in the Kanawha to get a tow ready to start from the mouth represents, in both time and expense, fully 300 miles distance with full tows in the Ohio River. After the slackwater is completed the greater part of the coal will undoubtedly be dropped down to the mouth of the river in low stages about as loaded (and with smaller tow-boats and at less expense than at present), and be ready to start

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down the Ohio whenever the water in that river will admit. In short, it appears that the completion of this improvement will not only nearly, or quite, double the season for shipping Kanawha coal, but that it will, in effect, place the Great Kanawha coal-field about 300 miles nearer to the markets of the Lower Ohio and Mississippi valleys.

The locks and dams will be of great advantage, too, in the coal business, in affording reliable navigation for the return of empty barges. This is now, in low stages, a source of much trouble and delay to the mines.

* * * * * * *

FREIGHT AND PASSENGER STEAMERS.

The following information, collected since your instructions of November 10 were received, in reference to the number and business of the Great Kanawha packet-boats —freight and passengers—is also submitted:

Number of packets in the trade in--

1875	6
1880	6
1886	10

The Great Kanawha packets have handled in the Kanawha trade during the twelve months ending December 1, 1883, about 41,000 tons of miscellaneous freight, mostly merchandise, farm produce, and the like. They have carried within the same time, as appears from their books, 59,355 passengers.

While coal is, of course, much the most important interest, the benefits of the completed improvement to the general freight and passenger business should not be overlooked. This trade (as appears from statistics given) is already of considerable importance. In addition to local packets, to some of which special reference has been made, there are four good steamers running regularly, except when prevented by low water, between the Upper Great Kanawha and points on the Ohio. One of them runs to Cincinnati, and one to Pittsburgh. Both of these are handsome, well-managed packets, of about 300 tons burden, and fitted up for about 70 passengers. They carry a great deal of freight and at low rates. The rates from Cincinnati to Charleston (263 miles) on general freight, as merchandise, etc., are from 10 to 15 cents per 100; from Pittsburgh (320 miles), about 15 and 20 cents per 100. The other two steamers in the trade to the Ohio run to points near the mouth of the Great Kanawha—Gallipolis, Pomeroy, etc. They make daily trips, carrying a good deal of freight and considerable many passengers. The reliable navigation to result from a completion of the locks and dams will, undoubtedly, encourage and develop very much this general steamboat trade, and inure to the material benefit of important enterprises and a large and increasing community.

E E 2.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

For want of funds nothing was done in the year ending June 30, 1886. The river and harbor act of August 5, 1886, contained an appropriation of $1,500. When it became available the season was too far advanced for its economical expenditure in 1886.

This river has been obstructed by mill-dams, etc., and it has been considered they should be removed if the improvement were to be continued by the United States. The legislature of West Virginia passed the following law in February 1887:

CHAPTER 46.—An act to provide for the removal of mill-dams and all other dams in Elk River, of this State, from the Webster County line to the mouth of said river, and in the Guyandotte River below the Wyoming County line.

Be it enacted by the legislature of West Virginia, 1. That all mill-dams and other dams in Elk River, of this State, between the mouth of said river and the Webster County line, and in the Guyandotte River below the Wyoming County line, which obstruct, impede, or interfere with navigation or floatage of boats or lumber, shall be deemed

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public nuisances, whether established under order of any court or act of the legislature, and the owners or occupiers of them may be jointly or separately indicted for maintaining the same, and on conviction, besides judgment of fine or imprisonment, or both, which the court may inflict, judgment shall be rendered that such dam be abated, and the court shall cause such judgment of abatement to be executed.

2. A suit in equity as for a public nuisance may be maintained against the owners and occupiers of such dam by any person prejudiced by the maintenance of such dam for its abatement, and upon its being found to be such nuisance, decree shall be rendered for its abatement and a civil action as far as public nuisance may be maintained against such owners or occupiers by any one injured, for damages resulting from such dam, and if in such action it be found that such dam is such nuisance, in addition to the judgment for damages and costs further judgment may be rendered that such dam may be abated, and the court shall cause the same to be executed.

3. It shall be no defense against such indictment, suit in equity, or civil action if such dam do obstruct, impede, or prejudice such navigation or floatage that it was erected under order of court or act of the legislature.

Approved February 24, 1887.

Up to the end of the fiscal year operations had not been resumed, and it is not likely they will be in 1887 unless under special circumstances.

Money statement.

Amount appropriated by act approved August 5, 1886	$1,500.00
July 1, 1887, amount available	1,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCE OF ELK RIVER, WEST VIRGINIA.

The following information is from a reliable source. The main business is that in timber:

Table showing statistics in reference to the timber business of Elk River, West Virginia.

Years.	Saw-mills in operation.	Lumber, 1,000 feet, B. M.	Oak staves.	Railroad ties.
1881	10	.....	.....	.....
1882	19	.....	.....	.....
1883	22	5,200,000	898,334	100,000
1884	24	5,975,000	1,222,500	125,000
1885	26	5,100,000	1,433,750	150,000
1886	28	*15,361,808	1,845,000	250,000

* It should be noted that a considerable part of the increase in lumber in 1886, given above, was due to the fact that it was a good year for "head rises." There were more "log-tides" from the headwaters in 1886 than on several years previous.

In view of the great quantities of fine timber on this stream, particularly on its upper waters, and the interest being taken in getting it out, it is evident that the business is now only in its infancy, and that the production in all its branches is going to increase rapidly and be important for many years.

In regard to the kinds of lumber from Elk, about one-half of it is poplar, the remainder being mostly oak, ash, and walnut. About 8 per cent. of all is walnut.

For a distance of 20 miles from the mouth (to Big Sandy Creek) freight is mostly carried in small flat-bottomed covered boats. Small steamers also run up as far as Big Sandy frequently in good stages of water, carrying freight and passengers, and towing stave, tie, and lumber barges.

Above Big Sandy and as far up as Braxton Court-House (100 miles from the mouth of the river) freight is carried in large canoes or dug-outs.

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E E 3.

IMPROVEMENT OF NEW RIVER FROM THE MOUTH OF WILSON, IN GRAYSON COUNTY, VIRGINIA, TO THE MOUTH OF GREENBRIER, IN WEST VIRGINIA.

After a suspension of operations for some years for want of funds an appropriation of $10,000 was made August 5, 1886, applicable, however, only to the portion of the river above the lead mines.

Doubt having arisen in view of the changed condition of affairs on and near the river as to the propriety of expending this appropriation at once, a special report was made to the Chief of Engineers May 19, 1887, as follows:

Referring to my request of April 8, approved April 13, for authority to have a reconnaissance made of New River, Virginia, above the lead mines in Wythe County, I have the honor to state that I employed for that purpose Mr. W. Proctor Smith, formerly of the Corps of Topographical Engineers, who had made a survey of that part of the river in 1878. His report of the survey may be found in the Annual Report of the Chief of Engineers for 1879, part 1, pages 538–545.

Previously an examination of the same portion of the river had been made by Mr. S. T. Abert, whose report, dated February 7, 1875, is in print in the Annual Report of the Chief of Engineers for 1875, part 2, pages 133–139.

Both of the reports referred to give much important information concerning the part of the river to which they relate. The former contains three estimates for the improvement of this stretch of the river of 62 miles as follows:

(1) For a 2-foot navigation for push boats 60 feet long, 7 feet wide, and carrying about 6 tons, with a channel not less than 30 feet wide, with tracking and towing paths at the falls and rapids	$115,000
(2) For a steamboat navigation, with a channel 90 feet wide and not less than 3 feet deep, with a grade always less than 1 in 400, including 28 locks and dams	1,200,000
(3) For a 5-foot stream navigation	1,600,000

Colonel Smith has lately inspected the upper river and submits a report, dated May 18, of which a copy is herewith.

Reference is requested to what was printed concerning New River in the Annual Report of the Chief of Engineers for 1886, which need not be now repeated.

Up to July 1, 1886, the money available for the upper portion of the river had amounted to $10,000, of which there had been expended $9,533.43, leaving a balance of $466.57.

In the law of August, 1886, there was a new appropriation of $10,000.

The season for work in the river in that section is short and it was too late to make economical beginning after August, 1886.

For reasons often mentioned in annual and special reports, no attempt has been made to give a continuous navigation of the New River (which rises near the line between North Carolina and Virginia, runs nearly north, receiving many tributaries) to Hinton, on the Chesapeake and Ohio Railroad, where the Greenbrier empties into it. A short distance above the Falls of the Great Kanawha River it unites with the Gauley to form the Great Kanawha River. The part of the river below Hinton is incapable of being navigable except at very great expense, and by resorting in some places to side canals. The Chesapeake and Ohio Railroad, now become a trunk line, is built upon the bank of the river below Hinton.

The portion of the river from the northern border of North Carolina to Hinton flows through a very picturesque country, sparsely populated, but containing a great and varied store of useful minerals, in some parts covered with large tracts of valuable timber, in others admirably adapted to agriculture and grazing. The most serious obstacle to a continuous navigation of the river above Hinton is Foster's Falls, which isolate the lead mines section from that immediately below.

Estimates for the improvement of the river above Hinton to the lead mines have been given in previous reports. These may be found in the Annual Report of the Chief of Engineers for 1873, pages 842–854.

As Congress has never given such a sum of money as would justify the proper beginning of a connected project for a continuous navigation from the North Carolina border to Hinton, the effort has been to apply such funds as were supplied in ameliorating the condition of the river and facilitating its use as a means of enabling the people to carry their salable products to the railroads which were in connection with the great markets of the Atlantic and the valley of the Mississippi. In carry-

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ing out this idea, there has been spent in the past ten years the sum of $58,000 in improving the portion of the river in the vicinity of New River Bridge, which is the point of intersection with the Norfolk and Western Railroad. The sum of $34,000 has been similarly spent on the portion of the river called the lower or Greenbrier section, which reaches the Chesapeake and Ohio Railroad at Hinton.

The question now is as to the best use to be made of the late appropriation of $10,000, which by the terms of the law can only be spent above the lead mines. As it is not likely Congress will in the near future supply the money necessary to make Foster's Falls passable and thus connect the upper and middle sections, it is supposed the same policy should continue of partial improvement in connection with the railroads. While there is much development in progress and more in prospect for the country on and near this upper section, yet the recent examinations of Colonel Smith seem to indicate that while the rafting of timber would be facilitated by spending the available $10,000 in the method suggested by him, that kind of navigation is already practicable, and the expenditure of the money would not be advantageous to any important extent to navigation by push-boats. Under all the circumstances it seems unnecessary to spend $10,000 on the upper New River in 1887, and it is accordingly recommended that the money be held in reserve.

The recommendation to refrain from expending the money was approved. It may be added that the improvement of New River above the point to which it has now been carried would be quite expensive, requiring a very heavy excavation of rock. It would be a very uneconomical proceeding to spend the available appropriation in view of the very small benefit it would cause. It does not revert to the Treasury at present.

Precise statistics could not be obtained for the last fiscal year for the reason that, no work having been in progress, there has been no one to collect them from the individual owners of the bateaux, that alone are employed in the navigation of the river.

Money statement.

July 1, 1886, amount available	$466.57
Amount appropriated by act approved August 5, 1886	10,000.00
	10,466.57
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	244.28
July 1, 1887, amount available	10,222.29
Amount (estimated) required for completion of existing project	159,000.00
Amount that can be profitably expended on lower river in fiscal year ending June 30, 1889	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. WILLIAM PROCTOR SMITH, ASSISTANT ENGINEER.

BALTIMORE, MD., *May* 18, 1887.

SIR: In compliance with your instructions to examine the resources and commerce of the section of country in Virginia through which New River runs, between the mouth of Wilson Creek and the lead mines, a distance of 62 miles, to ascertain whether they would warrant the expenditure of the $10,000 appropriated by Congress in August, 1886, I have the honor to report that on Monday, April 25, I went to Wytheville, Va., and thence to Ivanhoe Furnace, in Wythe County, on New River, 2.6 miles above the lead mines.

Making the furnace my starting point, I examined the country by making frequent horse-back trips, and find as follows: That in 1885-'86 a branch railroad was built from Martin's Station (now Pulaski City), on the Norfolk and Western Railroad, to a point on the river 23 miles above New River Bridge, and about the same distance by rail; thence the road was continued up to Foster's Falls (6 miles below the lead mines) when it stopped. Much work was also done on this road between Foster's

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Falls and Ivanhoe Furnace, which is to be resumed at once and completed this fall. Ivanhoe Furnace is 2 miles above the mouth of Cripple Creek, up which the railroad is to run, and is now called by its name.

This road is built principally to get at the iron, lead, zinc, copper, and other metals in this section. The charcoal furnaces are to be changed to coke.

Abundance of timber; oak, black, white, and red; pine, white, and yellow; and hemlock, poplar, lynn, and chestnut. Some of this is found at Crooked Creek, but the forests get heavier at and above the mouth of Chestnut Creek, 8 miles above Ivanhoe Furnace; thence the timber continues all the way up the stream and in large quantities in Alleghany, Ashe, and Watauga counties, North Carolina. The Carroll County Mineral Company owns 450 acres on Crooked Creek, 4 miles up; and 730 acres on Chestnut Creek, 5 miles up, which comes to within 1¼ miles of the river at Dixon's, 10.8 miles above the furnace; this property is full of black oxide and sulphate of copper and some iron.

The great magnetic vein of iron ore which runs through the country crosses the river here, and is now being developed, as it is also 2 miles above. Further up the stream there is plenty of copper; in fact minerals and timber abound beyond the usual amount found in any section of the same dimensions.

As regards the commerce proper of this section, I may say that through the mountains there is little else for transportation than timber and minerals; food supplies have frequently to be brought there.

Above the mountains the people raise some little more breadstuffs than they use, which are sold into North Carolina, off the river. Horses, stock cattle, and sheep are raised in very considerable quantities, but of course they are driven to market and do not affect the water route.

Considerable developments are being made, and mineral lands are much sought after and readily bought and sold.

The Cripple Creek Railroad Company is putting up a new iron furnace on Reed Island Creek, also one at Foster's Falls.

Ivanhoe Furnace is soon to be changed from charcoal to coke, and so are several others further up the creek.

A survey of the portion of the river under consideration was made under your direction in September, 1878, a report of which will be found in the Report of the Chief of Engineers U. S. Army, for 1879, Appendix F, commencing at page 539, to which you are respectfully referred, for it gives in detail much information with regard to the resources of this country.

From the above showing it will be seen that in timber and minerals the country abounds. The question now arises, can they be carried down the river through the channel, as it is now being made? The sum of $10,000 has already been expended, producing a channel 20 feet wide and 2 feet deep, at ordinary summer water, to within 400 feet of Fowler's Ferry, 6¼ miles above the lead mines and 3.65 miles above Ivanhoe Furnace.

The distance is given from the furnace, for it in the future must be the initial point of this work, if the plan of making the improvement tributary to the railroads running along the banks of the river and crossing the same is to be adhered to.

The grades being heavy and obstructions numerous, it was decided to make the channel only 20 feet wide, in order that the small appropriations might be made as useful as possible. This width, however, does not permit walls being built along which the boatmen could move and pull their boats. The current and natural channel, for the same reason, had to be followed, which makes the new channel very much curved in many places and somewhat difficult to navigate.

With an appropriation of $5,000 the channel as now made to Foster's Ferry, 6¼ miles, could be widened to 40 feet and the walls referred to be built with the extra material, and by an increased width the velocity would be diminished, thus enabling boats to go up as well as down, which is now very difficult and rarely attempted.

This width of 40 feet could be carried up the stream at a cost about double that of the 20-foot channel. The boats referred to are 60 feet long, 7 feet wide, and 3 feet deep, carrying about 6 tons.

With regard to rafting timber, the channel can be left as it now is, with the exception of straightening two points in Rogers's and cutting off two bends in Wilkinson's shoals; in fact a contract has been made to raft heavy oak timber down this channel in its incomplete state this summer. These timbers are for bridges and trestles on the Cripple Creek Railroad.

It is thought that the $10,000 now under consideration will make such a channel as far as Grayson Sulphur Springs, 6.8 miles above Ivanhoe Furnace, and into the timber region; anyhow it will make it as far as the New River Mineral Company's ferry at Crooked Creek, 5¾ miles above the initial point, where timber can be had, but not in such quantities as higher up the river.

It may as well be mentioned here that the heavy work in this section begins at Rogers' Shoals, 1.4 miles above Ivanhoe Furnace, and continues for nearly 14 miles

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through the mountains (river hills); thence to the mouth of Wilson Creek, 43 miles. With the exception of two falls, 10 miles below the stream mentioned, the stream can be easily and cheaply improved.

A map (scale 6 miles to the inch) of New River and its tributaries, from its sources in North Carolina, through Virginia, to the mouth of the Greenbrier, in West Virginia, showing the railroad following and crossing the same, accompanies this.*

A project for the expenditure of the $10,000 last appropriated to continue the improvement for the purpose of making a channel for rafting is herewith appended.

Respectfully submitted.

WM. PROCTOR SMITH.

Col. WILLIAM P. CRAIGHILL,
U. S. Engineers.

PROJECT FOR THE EXPENDITURE OF $10,000 APPROPRIATED AUGUST 5, 1886, FOR CONTINUING THE IMPROVEMENT OF NEW RIVER, VIRGINIA, BETWEEN THE MOUTH OF WILSON AND THE LEAD MINES IN WYTHE COUNTY, VIRGINIA.

4 canoes, at $20	$80
5 rock boats, at $25	125
1 skiff, at $25	25
Tools, tents, lumber, rope, chain, and camp outfit	450
	680

ROGERS' LEDGES.

(1.4 miles above Ivanhoe Furnace.)

To straighten channel and widen curve at upper ledge	300

WILKINSON'S SHOALS AND LEDGES.

(2.1 miles above Ivanhoe Furnace.)

To widen and smooth channel at forge and to widen at curve at Fish Trap	400
To finish channel at upper end, not completed in 1885	300

EARLY'S SHOALS.

(4.4 miles above Ivanhoe Furnace.)

10 ledges, flat slate, 25 to 35 feet wide each; almost continuous cutting; river broad; length about 300 feet; fall, 2.7 feet	1,800

ALLEY'S LEDGE.

(4.9 miles above Ivanhoe Furnace.)

6 scattering ledges, about 25 feet wide each; fall, 6.45 feet	450

GULF SHOALS.

(5.6 miles above Ivanhoe Furnace.)

Between one-half and three-fourths mile long; lower part very rough; runs between hills on either side; water swift; consists of 20 ledges slate; sometimes as many as 3 in a group; fall, 12.54 feet—10 feet in less than one-half the distance	4,000

CROOKED CREEK SHOALS.

(5¼ miles above Ivanhoe Furnace.)

5 ledges, close together; fall, 21½ feet	375

* Map omitted.—W. P. C.

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GRAYSON SPRING'S LEDGES.

(6.8 miles above Ivanhoe Furnace.)

Five-eighths mile in length; fall, 8 feet; 12 to 16 ledges, 10 to 25 feet wide each	$1,695
	10,000

Rather a small amount for the last shoal, but some money may be saved from the others. Early's Shoal has been estimated at much less, previously, but in fact it is with great difficulty one can get even a good approximate with water tolerably high and not clear. Rogers' and Wilkinson's ledges are not described, as they have been worked through and described fully in reports and projects.

In view of the difficulty of making accurate estimates as to quantity and quality of the material to be removed on which to ask bids for contracts, it is respectfully recommended that the work can be better and more economically carried on by procuring the labor and purchasing the materials in the open market.

E E 4.

PRELIMINARY EXAMINATION OF COAL RIVER, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., January 28, 1887.

GENERAL: Notice was received October 4, 1886, that the preliminary examination of Coal River, West Virginia, was placed in my charge, and an estimate of funds for making it was called for. It was October 29 before it could be known how much money was available for this object. The amount was very small.

A reconnaissance of the river was made in November, 1886, by Mr. Wm. C. Reynolds, as it was impracticable for me to attend to that duty in person, owing to the pressure of others of greater importance.

The original name of this river was Cole, but the present name is a very appropriate one.

The following account of the river is taken from the report of Mr. Reynolds:

Coal River empties into the Great Kanawha River 12 miles below Charleston and about 1 mile above the located site of Lock and Dam No. 7 of the Kanawha River improvement. Ascending the stream from its mouth, Coal River is found to follow a very winding course among low lying hills for 12 miles, then assuming a line of more graceful curves until a point is reached 18 miles up where the river divides into nearly equal forks, which are called, respectively, Big and Little Coal rivers.

From there it is about 70 miles to the heads of the two streams, which embrace a water-shed averaging 15 miles in width or over 1,000 square miles of territory.

With the exception of narrow strips of bottom land bordering the rivers and larger creeks, the whole area is covered with hills, which gradually increase in height, beginning at the forks with 300 feet and rising to a height near the heads of the rivers of 1,200 feet above the adjacent valleys.

The soil is naturally rich, even to the mountain tops, and the country generally devoid of the ruggedness characteristic of the majority of streams in this section of the State.

While the principal pursuit of the people here is farming for self-support, a considerable business has been carried on for fifty years or more in the cutting of timber, of which their rich mountain slopes contain the greatest abundance. Recent estimates place the amount of merchantable timber remaining in this district at 14,000 (B. M.) feet per acre. One-third of this I would judge to be poplar, one-third oak, and the rest walnut, hickory, ash, etc. But the lumber business languishes now, for reasons which I will endeavor to explain further along; and will first beg to call your attention to the geological, or rather mineralogical, features of the country.

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Coal River, as its name implies, is remarkably blessed in the abundance and fine quality of its coals. The mountains embrace above water-level that portion of the coal formation lying below the Pittsburgh Seam and above the great conglomerate rock, a vertical distance here of over 1,000 feet. The strata lie almost horizontal, rising but little faster than the stream as we ascend the valley, allowing vein after vein of coal to appear above the water-level, until, as has been reported, twenty or more have been counted near the upper waters. The coal is mostly highly bituminous; yet some of the lower strata seem to be suitable for gas and perhaps coking purposes. But the principal claim of this field for excellency above all others is in the quantity and fine quality of its cannel coal, which is the only coal that has ever been mined for shipment from Coal River; and a history of the enterprise connected with the shipment of this coal bears directly upon the subject of river improvement, for it is in consequence of the abandoned works of a co-operating navigation company that the present navigation of the river is most seriously obstructed.

The Coal River Navigation Company procured a charter from the State of Virginia March 17, 1849, and up to March 17, 1856, the State paid $96,000 on her stock and with this sum and other subscriptions somewhat exceeding this amount the company had in the mean time constructed eight locks and dams and established slackwater navigation from the Kanawha River to the Peytona cannel coal mines, on Big Coal River, a distance of 34 miles.

The shipment of coal was commenced in 1857, and continued until 1861, when the breaking out of the war put a stop to operations. After the war the company was revived, December 23, 1865, and the name changed to Navigation Company of Coal River, the works were put in repair and kept up until 1882, when they were abandoned. In my examination of Coal River, as I have been for a long time generally familiar with all parts of the stream, and was in possession of the notes of a survey which I conducted three years ago for a projected railroad from the mouth of the river to Walnut Gap at the head of Little Coal, I deemed it best to confine my labors in the field to the condition and present status of the works of the navigation company above mentioned.

All the dams from Nos. 4 to 8, inclusive, were found broken to their foundations and offering no obstruction to navigation, but Dams 2 and 3 are still kept up by parties owning flouring mills located at these points; also Dam No. 1, near the mouth of the river, is kept up by the owners of a steam saw-mill operating there.

The locks, which were simply cribs of timber and stone, are utterly decayed and wrecked at all the dams.

Lumbermen complain of these obstructions now as they are forced to turn their logs, etc., adrift in the stream and risk the chances of securing them again at some point below these dams, and, as a high tide is required to float the timbers over the dams, the rapidity of the current is then so great they are compelled to suffer much loss or at best are put to heavy expense in regaining their property, whereas, were these removed the lumber could be put into rafts as in former times at convenient points along the river, and these could be manned and guided down the stream in safety whenever there was sufficient tide to float them. That these dams are kept and maintained in violation of law there can be no doubt. The State of Virginia, by act January 31, 1834, declared this river a public highway from its mouth to designated points some 25 or 30 miles above the forks, and the franchises granted the navigation company, as I learned at the office of the secretary of state, are by the State of West Virginia declared forfeited, both by reason of non-usance and by failure to comply with the act requiring a certain annual tax to be paid by such corporations in order to perpetuate their franchises.

Coal River is a stream 270 feet wide at ordinary low water at its mouth and 200 feet at the forks. From there either fork carries a width of 150 to 125 feet for 20 miles up.

The bed of the river shows solid rock exposed in very many places, of which fact the old navigation company made good use, as nearly all their dams are located where the rock protrudes above the general bed of the river.

At Lock 2 or Lower Falls, 6 miles up, there was almost a perpendicular fall of 10 feet, at No. 3 or Upper Falls, 11½ miles up, there was about 8 feet.

The declivity of the river bed from the forks to the mouth, including the two falls, is about 2 feet per mile, or 35 feet in 18 miles. From the forks up Big Coal the slope is 3 feet per mile for 16 miles; up Little Coal it is 3 feet per mile for 10 miles, 3.6 the next 10, and a few miles beyond this the slope increases rapidly until within 5 miles of the head of the river it reaches 50 feet to the mile. With well-constructed dams, I think there is water enough to maintain slackwater navigation the year round.

The following information also comes from a reliable authority, Mr. H. W. Goodwin, long connected with the navigation of the river:

About the year 1849, Col. William M. Peyton, of Virginia, bought a large tract of land where Peytona is now located, contemplating opening and operating cannel coal

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mines and improving the river by slackwater navigation. He probably mined and shipped, when there was sufficient water in the river, 50,000 bushels of cannel coal prior to 1857. About 1853 or 1855 the property was purchased by New York and Philadelphia parties, forming an organization known as "The Virginia Cannel Coal Company" and "Western Mining and Manufacturing Company."

In the year 1849 a charter was granted to the Coal River Navigation Company, and preliminary arrangements made to commence work, funds being raised by stock subscription, and contribution from the Board of Public Works of Virginia.

Work of construction progressed very slowly until the year 1856 and 1857, when nine locks and dams were completed. Eight were located on Big Coal River, and Lock A on Little Coal River.

In the year 1858 there was very high water, injuring three or four of the locks and dams quite badly, and retarding the shipment of coal for some months. They being repaired, the navigation remained uninterrupted for any length of time until September, 1861, when there was a flood such as was never known in the valley, injuring more or less all of the locks and dams.

The war breaking out this year, the coal companies operating at Peytona closed their mines, and the river remained without care or attention until the year 1865, when the Peytona Cannel Coal Company was organized by Dr. Henry Du Bois, of New Haven, Conn. He and other New York capitalists formed the organization. Through his influence with foreign capitalists, stock was taken to purchase the franchise of Coal River, and rebuild the old locks and dams. This work was completed by the Navigation Company of Coal River, and the river opened for the passage of loaded barges and steamboats in the spring of 1867, and continued so without serious or long delays until the spring of 1881. The Peytona Cannel Coal Company closed their mines and suspended all work at Peytona December, 1880, owing to the decline in the price of their coal, and expense of operating their mines. In addition the locks and dams had become very much decayed, and the expense of thoroughly repairing them would not justify the outlay of money by the stockholders or Peytona Cannel Coal Company.

The following figures are quite accurate as to the cost of the improvements and the maintaining of the river works from year 1849 to 1851, and also from 1865 to 1881, made by the Coal River Navigation Company—

From year 1849 to 1861:	
Stock	$112,975.00
Board of Public Works	96,000.00
Bonds secured by trust	54,212.54
Tolls collected	16,293.99
Total amount expended by Coal River Navigation Company	279,481.53
Amount expended by Navigation Company of Coal River, repairing old works and maintaining same from year 1865 to 1880, inclusive	282,780.70
Paid for old works of river franchise	85,698.79
	368,479.49

The total receipts from coal and other sources did not, on an average, exceed $5,500 per year to the credit of the navigation companies.

The quantity of coal shipped down Coal River from the first opening of the cannel coal mines, viz:

Mined and shipped by Col. William M. Peyton, previous to the improvement of the river (estimated)	bushels	50,000
By the Western Mining and Manufacturing Company:		
1858 and 1859	do	400,000
Year 1860	do	800,000
1861 (estimated)	do	100,000
By Virginia Cannel Coal Company:		
1859 and 1860	do	732,328
1861	do	22,047
Total shipments of cannel coal up to 1861, inclusive	do	2,104,375
The Peytona Cannel Coal Company mined and shipped from year 1868 to 1880, inclusive	bushels	11,434,306
Total shipments from Peytona cannel coal-field at Peytona, Boone County, W. Va	bushels	13,538,681

or 536,547$\frac{480}{2000}$ tons.

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The following shows the original dimensions of the several locks and dams:

	Length.	Height.	Lift of lock.
	Feet.		
Dam No. 1	241	12.00	8.00
Dam No. 2	270	19.10	15.10
Dam No. 3	278	15.60	11.60
Dam No. 4	132	13.40	9.40
Dam No. 5	{110 / 160}	270	12.20	13.20
Dam No. 6	203	18.10	14.10
Dam No. 7	230	14.70	10.70
Dam No. 8	144	15.80	11.80
A—Little Coal	.....	17.60	13.50

It is thought that with good and well-constructed locks and dams, cheaply maintained, water could be secured to operate for nine months during the year, to pass boats or barges drawing from 3 to 5 feet of water.

The records for twelve years indicate that the average period of annual obstruction by ice was about thirty days and that the whole loss of time from low water and ice did not exceed ninety days each year for passing boats drawing from 30 to 50 inches.

A survey of this river is said to have been made many years ago by Gen. W. S. Rosecrans, or under his direction. I have seen a copy of the map in the possession of Maj. T. L. Brown, of Charleston, Kanawha county. The report I have not seen. There is no doubt of the existence of much very valuable coal and timber in the country drained by Coal River. Much interesting information on this subject can be found in the following papers:

(1) Annual reports of the Navigation Company, especially those of 1859 and 1866 by Maj. T. L. Brown, of Charleston, Kanawha county, kindly loaned me by Major Brown.

(2) Resources of West Virginia, by M. F. Maury and William M. Fontaine, 1876.

(3) Reports of Mr. John G. Stevens, in October, 1884, and of Bernhard E. Fernon to Hon. A. S. Hewitt, in 1883, loaned me by Major Brown.

(4) Report on the property of the Cabin Creek and Coal River Land Association, 1886, by Maj. Jed Hotchkiss, Staunton, Va.

This river has been already the subject of a slackwater navigation under the authority of the State. The locks and dams were not constructed in the best manner, probably from want of sufficient money, and in some cases the locations seem not to have been judiciously determined upon. The works have gone almost completely to decay and it is understood the charters of the navigation companies have no longer any force. The project has been a failure.

The owners of the property seem to prefer the construction of a railroad for its development. From the information available it is estimated the cost of improving this river with locks and dams well located and built would be not less than $1,750,000, this estimate having in view locks with chambers 25 feet by 125 feet in the clear and with 4 feet water on lower miter sill.

It is doubted, however, whether the water supply would suffice for a constant navigation of 4 feet. More detailed observations are necessary to settle that point. The annual cost of maintenance would be about $15,000.

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Under all the circumstances I cannot consider it judicious for the General Government to enter upon the improvement of this river, at least at this time, and therefore it becomes my duty, under the law, to say that in my opinion the stream is now "not worthy of improvement."

Very respectfully, your obedient servant.

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX F F.

IMPROVEMENT OF THE HARBOR AT DULUTH, MINNESOTA, AND AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN—IMPROVEMENT OF THE HARBORS AT GRAND MARAIS AND AGATE BAY, MINNESOTA.

REPORT OF CAPTAIN JAMES B. QUINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Duluth, Minnesota.
2. Harbor at Superior Bay and St. Louis Bay, Wisconsin.
3. Harbor at Agate Bay, Minnesota.
4. Harbor at Grand Marais, Minnesota.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 26, 1887.

GENERAL: I have the honor to transmit herewith annual reports upon works of river and harbor improvement at present in my charge, for the fiscal year ending June 30, 1887.

These works were transferred to me from Maj. Charles J. Allen, Corps of Engineers, on the 21st of September, 1886.

Very respectfully, your obedient servant,

JAMES B. QUINN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

F F 1.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

The act of Congress, approved August 5, 1886, making appropriation for the continuation of improvements at the harbor of Duluth, Minn., provided for the re-establishing of the dock line on the east side of Rice's Point. As it was possible that the area to be improved might be involved in this change no project for the commencement of work was considered till this question of new location of dock line was settled.

The location of this dock line was to be determined by the village council, subject to the approval of the honorable Secretary of War.

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Every facility was afforded those interested in the proposed change who called at this office to obtain a thorough understanding of the matter, and maps were supplied, upon which the different lines suggested were drawn. Much discussion naturally occurred, and it was not until the latter part of December that a final determination could be secured. The location of this line is shown on the accompanying map.

The extension of the dockage area necessarily absorbs the channel dredged between the Duluth Harbor and the Connor's Point Channel. It is, however, stipulated in the ordinance establishing the new dock line, that this channel is to remain unobstructed until a new channel shall have been substituted. Practically, but little use can be made of the privileged extension before a new channel shall have been created. The old channel is very narrow and has but 12 feet depth of water. It is, in consequence, of but very little use to the vessels which visit the harbor of either Duluth or Superior. In fact, vessels which may arrive with partial loads for both places prefer to make the round-about trip by way of the lake at considerable expense and loss of time, rather than accept the risks of navigating the shorter channel dredged along the old Rice's Point dock line.

This channel is, at present, of service mainly for the tugs and ferryboats which ply between Duluth and Superior, and will satisfy this minor local necessity until a better channel is provided.

NEW CHANNEL EAST OF RICE'S POINT.

The desirability of a suitable channel to connect the two harbors is indicated in the accompanying communications from the Chamber of Commerce of Duluth, herewith, and of the Chamber of Commerce of Superior, to be found with report upon that harbor.

It is gratifying to find such accordance of opinions between the two places upon a point which not long since was the subject of such fierce contention and strenuous opposition. It is certainly a very conspicuous indication of the fact that the commercial importance of the two places has at last reached that point in which petty village rivalry is supplanted by the broad and liberal views entertained by large cities upon the material advantages to be obtained by the extension of facilities for intercommunication.

The speedy construction of a new channel along the new dock line, east of Rice's Point, is advocated. In order that the United States may obtain some return for the relinquishment of the old channel to the dock owners of Rice's Point, it will be sufficient to locate this new channel so that it will not be less than 150 feet from the new dock line. The dock owners would then be obliged to dredge out this 150 feet between the channel and their docks before the docks would be accessible, and, although it is possible that shipping moored at these docks might occupy a large portion of this space, it is, nevertheless, a very material addition to the available harbor area, and, I think, would be ample return to the United States for whatever interests it may lose by abandoning the old channel.

The location of this proposed new channel is indicated on the accompanying chart of Superior Bay, etc. It would be 8,650 feet long, 200 feet wide, and have, when finished, an average depth of 17 feet.

Amount of material to be excavated, 622,200 cubic yards.

The removal of this material (including contingencies) would cost $119,552, which sum could be advantageously expended during the next season.

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A channel 150 feet wide would cost about one-fourth less money, but there is great danger that passing vessels would get aground and, in endeavoring to free themselves, seriously injure such channel with the material which would be displaced by the action of the propellers.

ENTRANCE PIERS.

The piers which line the entrance or canal through Minnesota Point are in a very decrepit state. These piers were originally built by the city of Duluth and railroads centering here, and were, necessarily, of an experimental character. I have no record of the formal transfer of the canal and piers to the United States, but I understand that the United States were tacitly yielded possession upon its assumption of the repairs and preservation of the works.

The canal has been free and no question of jurisdiction has as yet been raised.

For a short time the present piers will fulfill the object for which they were constructed. Until the exact position of the United States in the premises is specifically determined, it is not deemed prudent to undertake extensive repairs and alterations. It is hoped that this question, as well as some others concerning the location of a bridge crossing the canal, etc., will be speedily settled, and, until this occurs, a moderate expenditure to maintain the efficiency of the canal will suffice.

By the end of this season the canal piers will be in a fairly good condition, as far as can be at present determined, although the stability of the piers which line the canal is a subject of much uncertainty and anxiety, and it is quite impossible to predict the extent of damages to them which may result from the first severe storm.

The substructures of the piers are not believed to be sufficiently substantial in character, or properly placed, to warrant the erection upon them of masonry superstructures. They will likely have to be taken out and replaced by new work at considerable expense.

The commercial importance of this port would certainly warrant the expenditure of a much larger sum than would perhaps be required to entirely replace the present canal piers with structures of hewn stone, but the statistics of the port appear to me to plainly indicate that the time is not far distant when an additional canal will be requisite, and that just at present it is prudent to delay the reconstruction of the old piers until the requisite information regarding the new canal can be perfected.

Owing to the uncertain stability of the canal piers a reserve fund should be provided with which to repair damages, and this fund should be maintained at, at least $10,000. This amount should be available for next season's repairs, etc.

HARBOR BASIN.

The basin or free anchorage area of the Duluth Harbor has been gradually enlarged until, by the end of this season, it will comprise 107 acres dredged by the United States, and about 19 acres dredged by private parties in front of their docks, which together make the entire area bounded by the docks equal to about 126 acres.

The part dredged by the United States has an average length of about 3,000 feet and an average width of about 1,500 feet. The depth is slightly over 16 feet.

This area is as large as was recommended as adequate by the Board of Engineer Officers, convened in 1881, to consider this subject.

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When it is understood that a good many slips and docks have been recently constructed, any one of which may be said to add to the anchorage space of the harbor, the present area may be considered to be sufficient for the present.

It will eventually be necessary to extend it, shortly, on down the bay between the Park Point and Rice's Point dock line, but this exigency can be partially met by the dredging of the channels parallel with the dock lines in this locality.

PARK POINT CHANNEL.

The Park Point dock interests have not developed as yet, and it is believed that the construction of the channel recommended by the Board of Engineer Officers in 1881 would meet present and immediate prospective requirements.

The estimated cost of a channel 100 feet wide and 16 feet deep, parallel with the Park Point dock line, was placed at $15,800. This amount could be advantageously expended next season.

NORTH SHORE OF SAINT LOUIS BAY.

The present accessible dockage area is nearly all occupied, or will shortly be occupied, by shipping, docks, elevators, etc., and manufacturing establishments and similar enterprises, requiring access to navigable water, have been obliged to seek less expensive sites, and have accordingly, located along the north shore of St. Louis Bay and on the banks of the St. Louis River.

The location of several important manufactories in this locality is assured, and some are already in process of erection. It is just as difficult to predict the prospective magnitude and importance of these new industries as it was that Duluth should become one of the greatest grain markets in the world.

If, with the present inadequate navigable channels available, large manufacturing associations do not hesitate to establish their works in the localities mentioned, it is safe to infer that the inducements would be greatly augmented if easy access to deep water was assured. The excavation required to give a good channel through the St. Louis Bay, from deep water at Rice's Point to deep water at Grassy Point, would prove a serious embarrassment to private enterprises, although I have no doubt it would be provided for, whatever the hardships might be, but, in view of the commercial advantages which are certain to accrue to the commerce of the country, and the further fact that such channel must lie within the navigable waters over which the General Government holds jurisdiction, indicates the propriety of this work being national instead of private in origin.

A dock line has been established between the deep water at Rice's Point and Grassy Point. The proposed channel is located 150 feet outside this dock line, and if constructed, as shown on accompanying tracing of St. Louis Bay, would have a length of 12,900 feet and a width of 200 feet, a depth of 17 feet, and would cost $163,800. If it is made but 100 feet wide it would cost about $82,000. The 100-foot channel could be excavated in one season. It is important that this channel be excavated at as early a day as possible.

SAINT LOUIS RIVER.

It is rumored that several large flouring mills will be shortly established on this river, in the vicinity of Fond du Lac. There is splendid water power for such establishments on this river, and it is within the

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range of possibilities that some improvement to the channel of the St. Louis River may be required shortly.

There is almost uninterrupted navigation for vessels drawing 12 feet of water as far as the log-booms below Fond du Lac.

The tracing showing the channel of this river as far as the first rapids accompanies this report, but no estimate of the cost of improvement is submitted at present, for the reason that the developed interests are not sufficiently defined to indicate the character of work required.

FACILITIES FOR INSPECTION.

The extent of the areas covered by the improvements in Superior and St. Louis Bays, and the very limited time available for taking soundings and making other necessary examinations, not to mention the large amount of inspection service necessary during the working season, makes it desirable to have some other means of transportation than that afforded by ordinary rowboats.

A small steamlaunch has, I think, become necessary, and it is hoped that provision for the purchase of one may be made.

Delivered at Duluth, Minn., a suitable steam-launch should not cost over $2,000.

RÉSUMÉ OF RECOMMENDATIONS.

For new channel east of Rice's Point, including contingencies	$119,552
For repairs to canal or entrance piers	10,000
For Park Point Channel	15,800
For dredging channel, north shore of St. Louis Bay	82,000
For steamlaunch, for inspection, etc	2,000
Total	229,352

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the south pier of Duluth Canal, Minn.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT DULUTH, MINNESOTA.

By act of Congress approved March 3, 1871	$60,000.00
By act of Congress approved June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	36,049.20
By act of Congress approved June 23, 1874	10,000.00
By act of Congress approved March 3, 1875	35,000.00
By act of Congress approved August 14, 1876	15,000.00
By act of Congress approved June 18, 1878	30,000.00
By act of Congress approved March 3, 1879	25,000.00
By act of Congress approved June 14, 1880	25,000.00
By act of Congress approved March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved July 5, 1884	45,000.00
By act of Congress approved August 5, 1886	56,250.00
Total	472,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying and contingencies.

TOTAL AMOUNT EXPENDED TO JUNE 30, 1887.

Breakwater	$110,000.00
Canal piers, etc	65,616.63
Dredging	252,936.17
Reserved by Chief of Engineers	227.90
Total	428,780.70
Balance available July 1, 1887	$43,518.50
Outstanding liabilities July 1, 1887	1,107.58

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AMOUNT EXPENDED PRIOR TO PRESENT PROJECT.

Breakwater	$110,000.00
Canal piers, etc	45,698.33
Dredging, etc	114,953.48
Total	270,651.81

AMOUNT EXPENDED UNDER PRESENT PROJECT (ADOPTED IN 1881) TO JUNE 30, 1887.

Canal piers, etc	$19,918.30
Dredging, etc	137,982.69
Reserved by Chief of Engineers	227.90
Total	158,128.89
Estimate for carrying out present project, adopted in 1881	212,988.36
Increased cost for reasons stated in annual report of Major Charles J. Allen for 1884	92,435.64
Total	305,424.00
Amount appropriated under present project	186,250.00
Balance required for present project	119,174.00
Additional amount required for new work	285,352.00
Total required for extended project	404,526.00
Amount required annually for preserving and maintaining	10,000.00

Money statement.

July 1, 1886, amount available		$1,772.10
Amount appropriated by act approved August 5, 1886		56,250.00
		58,022.10
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$14,731.50	
July 1, 1887, outstanding liabilities	1,107.58	
		15,839.08
July 1, 1887, amount available		42,183.02
Amount (estimated) required for completion of existing project		590,776.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		229,352.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract for proposals received for dredging in the harbor of Duluth, Minn., repairs to the piers of canal and placing buoys in the harbor, and opened April 7, 1887, at Duluth, Minn., by Capt. James B. Quinn, Corps of Engineers.

No.	Names and addresses of bidders.	Prices bid for dredging, per cubic yard.	Total prices bid for repairs to the piers of canal.	Total prices bid for placing 25 buoys in the harbor.
		Cents.		
1	Carkin, Stickney & Cram, East Saginaw, Mich	26½		
2	Truman & Cooper, Manitowoc, Wis	17½		
3	Peter Lambert, Duluth, Minn		$10,705.75	
4	Norris G. Dodge, Chicago, Ill	19		
5	Renseler R. Dodge, Fulton, N. Y	22		
6	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	18		
7	Charles S. Barker, Duluth, Minn	15 2/10	7,800.00	$375.00
8	Williams, Upham & Co., Duluth, Minn	15½		

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Contracts were awarded, with the approval of the Chief of Engineers, as follows: To Williams, Upham & Co., for dredging; Charles S. Barker, for repairs to the piers of canal and for placing buoys in the harbor.

Dredging to be commenced on or before May 15, 1887, and completed by October 1, 1887. Repairs to the piers of canal to be commenced on or before May 15, 1887, and completed by September 1, 1887. Buoys to be set in the harbor by June 1, 1887.

Abstract of proposals received for placing a new crib and driving close piling in old crib at outer end of south pier of Duluth Canal, Minnesota, and opened June 21, 1887, at Duluth, Minn., by Capt. James B. Quinn, Corps of Engineers.

No.	Names and addresses of bidders.	Total prices bid for the work.
1	Charles S. Barker, Duluth, Minn	$2,950
2	Steele Brothers & Co., Duluth, Minn	3,394
3	William L. McLennan, Duluth, Minn	3,999

Contract awarded to Charles S. Barker, with the approval of the Chief of Engineers.

Contract dated June 24, 1887. Work to be commenced on or before July 1, 1887, and completed on or before July 22, 1887.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels.

Years.	Number of vessels.	Tonnage.
From May 7 to June 30, 1887	788	614,919
Corresponding period in 1886	600	495,282
Increase	188	119,637

Exports for May and June, 1887		$1,523,546
Shipments of wheat for May and June:		
1887	bushels..	8,738,600
1886	do....	5,089,313
Increase	do....	3,649,287
Receipts of coal for May and June:		
1887	tons..	301,600
1886	do....	124,900
Increase	do....	176,700

Arrivals and clearances of vessels for 1885 *and* 1886.

Years.	Vessels.	Total tonnage.	Average tonnage.
1886	2,021	1,569,068	776
1885	1,797	1,371,869	763
Increase	224	197,199	13

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Comparative statement of arrivals and clearances of vessels at Duluth for ten years.

Years.	Arrivals.	Clearances.	Total.	Years.	Arrivals.	Clearances.	Total.
1877	329	328	657	1882	833	832	1,665
1878	406	343	749	1883	796	779	1,575
1879	502	497	999	1884	888	903	1,791
1880	524	524	1,048	1885	898	899	1,797
1881	666	660	1,326	1886	1,026	995	2,021

Imports for year 1886:
Value $69,898.00
Duties 3,765.27
Exports for year 1886, value 2,419,847.00

The "in transit" trade for 1885 *and* 1886.

Years.	Value of merchandise.	Duties.
1886	$94,510.00	$52,576.97
1885	96,385.00	46,971.11

The following table gives the receipts and shipments of wheat for sixteen years at Duluth:

Years.	Receipts.	Shipments.	Years.	Receipts.	Shipments.
	Bushels.	*Bushels.*		*Bushels.*	*Bushels.*
Year ending December 31,			1879	1,524,065	1,487,222
1886	22,532,574	17,668,251	1878	1,803,090	1,782,358
1885	14,869,675	14,065,775	1877	460,595	503,899
1884	13,722,930	11,551,582	1876	1,451,190	1,376,392
Year ending August 31,			1875	1,137,721	1,081,194
1883	4,707,803	4,586,908	1874	2,407,476	2,424,176
1882	3,266,242	3,325,498	1873	1,981,453	1,583,173
1881	3,332,176	2,865,536	1872	931,611	951,046
1880	1,347,679	1,453,674	1871	556,783	544,848

Total freight received and shipped by the Saint Paul and Duluth and Northern Pacific railroads at Duluth, during 1886, 3,354,959,541 pounds.

Receipts of coal and flour at Duluth.

Years.	Coal.	Flour for shipment eastward.
	Tons.	*Barrels.*
1886	732,000	1,483,570
1885	595,000	1,076,044
Increase	137,000	407,526

Grain shipments by lake from Duluth.

Year.	Wheat.	Corn.	Oats.	Barley.	Flaxseed.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
1886	17,668,251	121,871	500	21,407	5,226	17,817,255
1885	14,065,775	93,287	91,269	38,681	.....	14,289,012
Increase	3,602,476	28,584	.....	.....	5,226	3,528,243
Decrease	.....	.....	90,769	17,274	.....	.....

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The receipts of coarse grains, such as corn, oats, barley, and flaxseed, were 291,652 bushels during 1886.

GRAIN STORAGE.

	Bushels.
Grain storage capacity December 31, 1886	11,150,000
In course of construction to be completed by September 1, 1887	8,050,000
Total	19,200,000

Lake freight rates from Duluth, during 1886, averaged from 2¼ cents early in the season to 8¼ cents at the close.

Opening and closing of navigation.

Years.	Opening.	Closing.
1885	April 27	November 29
1886	April 7	December 14
1887, first boat departed	May 4	

NOTE.—The dates of opening and closing of navigation by years, 1865–'84, are given in Annual Report of the Chief of Engineers for 1885.

LETTER OF THE CHAMBER OF COMMERCE OF DULUTH, MINNESOTA.

CHAMBER OF COMMERCE, SECRETARY'S OFFICE,
Duluth, Minn., July 6, 1887.

SIR: At a meeting of the board of directors of this chamber, held July 1, the inclosed memorandum of the improvements needed during the ensuing year was unanimously adopted as an expression of the views of the chamber and of the business community generally, and the secretary was directed to transmit the same to you for your information, with the request that estimates for the work be included in your report to the Government, soon to be rendered.

With great respect, truly yours,

WM. F. PHELPS,
Secretary.

Capt. JAMES B. QUINN, U. S. A.

MEMORANDUM OF IMPROVEMENTS NEEDED IN THE HARBOR OF DULUTH DURING THE YEAR 1888–'89.

The Chamber of Commerce of Duluth respectfully submits for the consideration of the Government the following memorandum relating to the work to be done in the harbor of Duluth during the next year:

The commerce of Duluth has increased and is increasing so rapidly as to demand improvements on a far greater scale than at any previous time.

The custom-house reports for the season of 1886 give an aggregate of arrivals and clearances of vessels at this harbor of 2,181, with a total tonnage of 1,694,864 tons, being an average of about 800 tons each, and indicating a constant increase in the number and carrying capacity of the vessels doing business here.

With the improvements projected and in progress at the Sault Ste. Marie River and Canal, the number and draught of vessels arriving here will be still further augmented, rendering the improvements herein indicated still more imperative.

The value of our exports to foreign countries in 1886 was		$2,419,847
Shipments of wheat	bushels..	17,668,251
Shipments of flour	barrels..	1,500,000
Receipts of coal by lake	tons..	736,000
Receipts of oil by lake	gallons..	3,141,900
Receipts of fish	pounds..	872,437
Receipts of railway iron	tons..	75,040

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From the opening of navigation, May 7, 1887, the arrivals and clearances of vessels have been		$78[illegible]
The arrivals and clearances for the same period in 1886 were		600
Increase in 1887		188
Exports for May and June, 1887		$1,523,546
Shipments of wheat for May and June—		
1887	bushels..	8,738,600
1886	do....	5,089,313
Increase in 1887	do....	3,649,287
Receipts of coal for May and June—		
1887	tons..	301,600
1886	do...	124,900
Increase in 1887	do...	176,700

This rapid increase of business, only partially indicated above, has compelled a great extension of our dockage and warehouse facilities. During the past twelve months there have been built nearly 10,000 linear feet of additional dock frontage in the Bay of Duluth alone, much of it with substantial warehouses and grain elevators. Further extensions of these facilities for our growing business must be continued down the inner face of Minnesota Point, along both sides of Rice's Point and the Minnesota shore of St. Louis Bay. On the latter considerable developments have already taken place, and industrial establishments of magnitude are already commenced, including works for the reduction of iron, copper, and silver ores, and for lumber and wood working, all of which will require connection with the waters of Lake Superior by the most direct channels for the receipt of materials and fuel and the shipment of manufactured products.

We feel impelled as the representatives of the commercial interests of the city of Duluth, whose importance as a lake port for a vast extent of territory is rapidly increasing, further to record our conviction of the entire inadequacy of the piers and crib-work along the ship-canal leading into the harbor. They are constructed mainly of timber, are unstable, constantly yielding to the action of the current, and, in our judgment, are totally inadequate properly to protect the canal and the shipping that is passing in and out of the harbor. This is especially the case during a stress of weather. The fact that the pier has been virtually condemned by the light-house authorities as unfit for the location of the machinery to operate a flash-light for the safe guidance of vessels into the harbor during the night, is significant of the work that should be done to perfect the approaches thereto.

We desire urgently to press upon the attention of the Government that the improvement of this harbor can no longer be properly confined to its past slow rate of progress and restricted cost, but must be based on the requirements of this already established port of entry, and of shipments for several great States and Territories, whose commerce has no other water-route to the Atlantic sea-board.

We urge that the plans of work for the ensuing year should embrace:

(1) The enlargement of the area of the harbor of refuge inside of the Duluth Canal at least 50 per cent. beyond its present dimensions.

(2) A channel along the established dock line of Minnesota Point 100 feet in width, 1 mile.

(3) A channel 150 feet in width along the established dock line on the east and south sides of Rice's Point, to connect the two harbors of Duluth and Superior.

(4) A channel 75 feet in width from the end of the natural channel on the west side of Rice's Point along the established Minnesota dock line to deep water at the head of St. Louis Bay, near Grassy Point.

(5) The piers flanking the ship-canal should be entirely reconstructed of masonry, in the most substantial manner, with proper approaches at the lake end and breakwater on each side for the protection of shipping entering the harbor during stormy weather.

And that the estimates should be for a sum that will complete this work in one year, so far as the same may be practicable.

We recognize the fact that this schedule of work is a great advance upon the very small scale of past years. But, asserting that this is really needed, and at once, we insist that no harbor improvement in the United States will benefit so great an area of territory or be productive of practical value to so great a number of people.

By the board of directors.

WILLIAM F. PHELPS,
Secretary.

CHAMBER OF COMMERCE,
Duluth, Minn., July 1, 1887.

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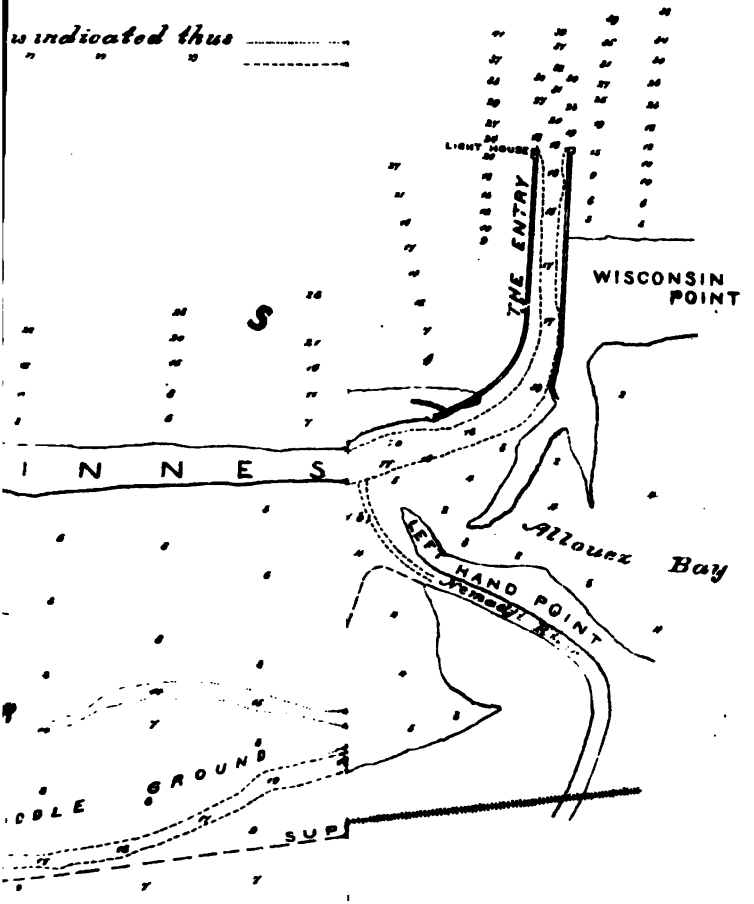

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F F 2.

IMPROVEMENT OF HARBOR AT SUPERIOR BAY AND SAINT LOUIS BAY, WISCONSIN.

The piers of the natural entry to Superior Bay have been gradually extended until they have reached the following lengths: North Pier, 3,150 feet; South Pier; 2,500 feet.

The superstructure of both these piers is in a more or less decayed state, and will require a large sum of money to put them in good repair.

Of the money appropriated by act approved August 5, 1886, a portion was allotted for the repairs of these piers, but upon subsequent consideration it was concluded that the amount would not effect much in the way of general repairs, and might be much less than necessary to repair possible damages resulting from storms.

At present, the piers answer the purpose for which they were constructed, but there must, sooner or later, come a time when, from storms or other causes, extensive reconstruction will be imperative. Ordinary prudence indicates the propriety of accumulating a sufficient fund to meet such exigency. In fact, since a further extension of the piers will soon be necessary, it appears likely that the time is not far distant when this entry will be abandoned for a new construction in a more generally useful place.

To replace the superstructure of these piers with concrete faced with stone would cost over $280,000. In addition to this it must be understood that very soon each pier will have to be extended 500 feet to insure proper depth between them at the outer ends. This extension will cost not less than $100,000. Since the advance of the shore line on the south side of the piers averages 46 feet a year, at the end of eleven or twelve years a further extension would be necessary, and if 20 feet depth is required to conform to depths required shortly in other ports, the expense of maintenance, extension, etc., of this entrance would be increased beyond any warranted expenditure on account of benefits to the commerce which may use it.

The channel between the piers makes an abrupt bend at the point where it enters Superior Bay. A vessel entering during a severe storm consequently has great difficulty in following this channel, and this defect can not be remedied for the reason that the Nemadji River enters the bay so near this entry that the bar which it maintains at its mouth will not permit a change in the location of the channel; in fact, the shoaling in the ship channel near the entry is doubtless due to the detritus of this river.

As far as the wishes of navigators are concerned the location of an entry opposite the point where the St. Louis River enters Superior Bay, or at about the middle of Minnesota Point, would be better than to maintain two separate entrances to the same bay as at present, but the existence of a suitable channel between Duluth Harbor and the Superior Bay Channel would contribute much to their convenience and be of much benefit to the city of Old Superior.

Whatever may be the outcome of these speculations it does not seem proper to advise the annual expenditure of a greater sum than $10,000 for the maintenance of the entry piers, and $5,000 for dredging and maintaining channel in their vicinity, a total of $15,000, which amount can be expended judiciously next year.

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BASIN AT OLD SUPERIOR.

This free anchorage area has been extended from year to year, and will be deepened and improved during the present year. Its dimensions will then be ample for the accommodation of all the commercial enterprises located in its immediate vicinity.

It is liable to shoaling from the fact that the Nemadji River debouches near it, and some of the sediment of this river, under certain circumstances, is deposited over the area being dredged. To preserve this area at present depth the sum of $2,000 will be required for next season.

CHANNEL IN SUPERIOR BAY.

Most of the shipping which uses the Superior entry proceeds on up the bay to Connor's Point and West Superior.

The importance of this commerce can best be ascertained from the inspection of the statistics, and the letter from the Chamber of Commerce of West Superior which accompanies this report.

I can but briefly allude to it as simply marvelous, particularly when one stops to consider the difficulties that vessels must encounter between the entry and the docks at West Superior and the proximity of Duluth, with its commodious harbor.

It is not surprising that there should be urgent demand for the improvement of the channel between Superior entry and Connor's Point and its maintenance in good condition till better facilities can be provided. Much relief may be obtained by straightening the channel at the middle ground.

At present prices for dredging this will cost $15,000, and can be economically expended during next season.

CHANNEL BETWEEN CONNOR'S POINT AND DULUTH HARBOR.

It is quite evident that some more convenient access to the lake is needed than that afforded by way of the Old Superior entrance, and for this reason the channel parallel to Rice's Point dock-line is desired. This channel is considered in report upon Duluth Harbor and is estimated to cost $119,552. (See Report upon Duluth Harbor.)

NEW ENTRANCE.

It is believed that a new and more commodious entrance to the harbor areas in Superior Bay and adjoining waters will be soon required. The precise location of this new opening has not as yet been determined. Its location opposite the gate at Connor's Point is advocated by some. It is possible, however, that the interests of Superior and Duluth may desire it to be located nearer midway between the two entries.

As such an entry should be devised to answer the necessities of whatever commerce may focus at the western extremity of Lake Superior, and as the statistical information accompanying this report, as well as that upon Duluth Harbor, affords evidence that this commerce may even exceed in magnitude the most sanguine expectations, it is obvious that some means should be provided to enable the necessary data to be obtained, and requisite plans and specifications to be prepared.

This will involve some special examinations of proposed sites, and considerable drawing and computations. This work will cost $2,500, which should be available as early as possible.

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CHANNEL ALONG WISCONSIN DOCK LINE, ST. LOUIS BAY.

Some rectification and deepening of the channel commencing at the deep water at Connor's Point and extending up St. Louis Bay parallel with the established dock line on the Wisconsin side, has been done during the present season, and is still in progress.

The principal docks, elevators, and warehouses for the use of the shipping, which at present makes use of the Superior Entry, are located along this St. Louis Bay dock line. As these facilities are being rapidly extended, the completion of the channel to deep water at Grassy Point is much needed, and should be expedited as much as possible. This channel will be 8,810 feet long and 200 feet wide. (See chart of St. Louis Bay with report upon Duluth Harbor.)

It will cost $112,156, which amount can be expeditiously expended during the next working season.

FACILITIES FOR INSPECTION.

The localities under improvement and proposed improvement are at considerable distances apart; for convenience in making the necessary inspections a small steamlaunch should be provided. A suitable boat of this kind may be purchased for $2,000.

DREDGING OUTFIT FOR DULUTH AND SUPERIOR HARBORS.

The act of Congress approved August 5, 1886, provided that estimates be supplied giving the cost of a dredging plant for the harbors of Duluth and Superior.

I have obtained such data as was possible by correspondence with manufacturers and personal conferences with dredge-owners.

It is not believed that suitable dredging plant can be obtained for less than the following sums, viz:

1 dipper-dredge, complete, with outfit and necessary equipment	$26,000
1 tug, complete, with necessary equipments, etc	12,000
2 dump-scows, with equipment	6,000
Total for plant	44,000

The cost of running such a plant would be as follows, per month:

Wages	$760
Board of employés	210
Lubricants and lights	25
Laundry expenses	15
Sundry expenses, not enumerated	20
Coal, at $7 per ton	819
Repairs	300
Depreciation of plant	366
	2,515

If such a plant averages 1,000 cubic yards of excavation per day, or say 26,000 cubic yards per month, which assumes that there shall be no extensive delays on account of breakages or bad weather, the cost per cubic yard would be $0.0966, or say, practically, 10 cents.

This is a favorable showing, for the reason that it does not include any extraordinary breakages, repairs to plant, insurance, or cost of supervision, which items probably would make the actual cost to those who have to accept these latter items as part of the cost of dredging

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fully 15 cents per cubic yard. If the material has to be transported over a mile the cost is considerably increased.

As there is satisfactory competition among dredging contractors at this place at present, there does not appear to be any advantages of sufficient importance to warrant the Government investing in a dredging outfit.

RESUMÉ OF RECOMMENDATIONS.

For maintenance of piers at the entry	$10,000
For dredging and maintaining channel in vicinity of entry piers	5,000
For preservation of dredged area in basin at Old Superior	2,000
For channel in Superior Bay	15,000
For examinations, plans, etc., for proposed new entrance	2,500
For channel along Wisconsin dock line, St. Louis Bay	112,156
Facilities for inspection	2,000
	148,656

Superior, West Superior, and Connor's Point are in the collection district of Superior, Wis., Marquette, Mich., being the port of entry. The nearest light-house is situated on the entry piers at Superior, Wis.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

By act of Congress approved March 3, 1867	$63,000.00
By act of Congress approved April 10, 1869	45,000.00
By act of Congress approved July 7, 1870	40,000.00
By act of Congress approved March 3, 1871	60,000.00
By act of Congress approved June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	63,950.80
Allotted from appropriation for "repairs of harbors on northern lakes"	5,433.00
By act of Congress approved August 14, 1876	3,000.00
By act of Congress approved June 18, 1878	3,000.00
By act of Congress approved March 3, 1879	5,000.00
By act of Congress approved June 14, 1880	5,000.00
By act of Congress approved March 3, 1881	10,000.00
By act of Congress passed August 2, 1882	40,000.00
By act of Congress approved July 5, 1884	45,000.00
By act of Congress approved August 5, 1886	22,500.00
Total	460,883.80
Amount adopted under original project, adopted in 1867	258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1887	105,778.41
Reserved by Chief of Engineers	4.30
Total	441,295.97
Estimate for carrying out present project, adopted in 1881	312,080.00
Act of July 5, 1884, added improvement of the St. Louis River Channel within the bay of Superior, the estimated cost of which was (see annual report of Maj. Charles J. Allen for 1885)	33,000.00
Estimated cost of present project	345,080.00
Appropriated under present project	117,500.00
Balance required for present project	227,580.00
Additional amount required for new work	114,156.00
Total required for extended project	341,836.00

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different

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classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Repairs and beach protection	$13,233.00
Construction, and repairs to piers	318,173.53
Dredging	109,885.14
Reserved by Chief of Engineers	4.30
Total	441,295.97
Balance available July 1, 1887	19,587.83
Outstanding liabilities July 1, 1887	508.95
Estimated amount required annually for preserving and maintaining	10,000.00

Money statement.

July 1, 1886, amount available		$3,349.11
Amount appropriated by act approved August 5, 1886		22,500.00
		25,849.11
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,265.58	
July 1, 1887, outstanding liabilities	508.95	
		6,774.53
July 1, 1887, amount available		19,074.58
Amount (estimated) required for completion of existing project		341,836.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		148,656.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for dredging in Superior Bay and St. Louis Bay, Wisconsin, and opened December 13, 1886, at Duluth, Minn., by Capt. James B. Quinn, Corps of Engineers.

No.	Names and addresses of bidders.	Prices bid for dredging, per cubic yard.
		Cents.
1	Truman & Cooper, Manitowoc, Wis	22
2	Chicago Dredging and Dock Company, Chicago, Ill	25
3	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	19½
4	Renseler R. Dodge, Fulton, N. Y	19
5	Charles S. Barker, Duluth, Minn	*18
6	Williams, Upham & Co., Duluth, Minn	19½

*Lowest bid.

Contract awarded to Charles S. Barker, with the approval of the Chief of Engineers. Contract dated December 21, 1886. Work to be commenced on or before June 1, 1887, and completed by September 1, 1887.

COMMERCIAL STATISTICS.

Receipts and shipments for May and June, 1887.

	Receipts.		Shipments.	
	Vessels.	Merchandise.	Vessels.	Merchandise.
	No.	*Tons.*	*No.*	*Tons.*
May	24	31,929	11	14,356
June	48	66,043	14	17,989
Total	72	97,972	25	32,345

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Comparative statement of arrivals and clearances of vessels for four years.

Years.	Vessels.	Total tonnage.
1886	316	271,190
1885	260	189,768
1884	194	115,872
1883	20	15,468

Receipts of freight by lake during 1886.

Commodities.	Quantity.	Value.
Coal.....tons..	176,918	$1 061,508
Iron.....do...	22,781	911,240
Logs.....feet, B. M..	40,000,000	320,000
Oil.....barrels..	1,000	6,500
Miscellaneous freight.....pounds..	1,000,000	100,000
Total.....	.....	2,399,248

Shipments of freight by lake during 1886.

Commodities	Quantities.	Value.
Lumber.....feet, B. M..	35,000,000	$525,000
Shingles.....number..	1,000,000	3,000
Brick.....do....	1,000,000	6,000
Miscellaneous freight.....tons..	20,000	200,000
Cattle.....number..	3,000	120,000
Total.....	.....	854,000

Comparative statement of receipts and shipments for three years.

Years.	Value.
1886	$3,253,248
1885	934,805
1884	484,395

COMMUNICATION FROM THE WEST SUPERIOR CHAMBER OF COMMERCE.

Whereas the demand of commerce at the port of West Superior, Wis., for increased facilities for shipping is such, that it becomes necessary to continue the dredging and improvement of the existing channel in St. Louis Bay, and a continuation of the same to deep water at Grassy Point, the Superior entry, and the improvement and maintenance of the Government piers at said entry, and the dredging of a new and sufficient channel connecting deep water at Connor's Point with the Duluth Harbor. Therefore your petitioners, the West Superior Chamber of Commerce, would most respectfully memorialize you to embody in your forthcoming report to the Secretary of War such recommendations for appropriations as in your judgment will be necessary to complete the improvements above suggested.

O. N. MURDOCK, *President.*
M. B. KIMBALL, *Secretary.*

To Captain QUINN.

ARGUMENTS IN SUPPORT OF FOREGOING MEMORIAL.

The arguments which we have to offer in support of the foregoing memorial are, the existence here of the following railway terminals, viz: Chicago, Saint Paul, Minneapolis and Omaha, controlling and operating about 2,000 miles of road, and which is putting in $1,000,000 worth of improvements here the present season in docks, elevators, warehouses, yard-tracks, etc.; the St. Paul and Duluth, whose improvements being made here this season in bridging, yard-tracks, warehouses, etc., will approximate $500,000; the Duluth, South Shore and Atlantic, a line now being con-

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structed between the Sault Ste. Marie and this place, contemplating extensive improvements here; the Northern Pacific, which has extensive unimproved terminal facilities here, where the headquarters of its Wisconsin Division now are, and which is doing a large and rapidly increasing business and has in view the improvement of its grounds at this place in the near future; the St. Paul, Minneapolis and Manitoba, whose lines at present are equal in extent to those of the great Northern Pacific and which it will soon exceed, having 200 acres of land here for terminal facilities, and designing in the near future to make this its main terminal, where it will construct its shops at an estimated cost of $3,000,000 and constantly employ from 1,500 to 2,000 men, already having 9 miles of yard-track, which amount is now being doubled. This company now owns and operates here the largest elevator on Lake Superior, having a capacity of 2,000,000 bushels, and which will be duplicated the present season. This elevator during the month of June handled more wheat than all others at the head of the lake combined. Terminal facilities are also owned here by the Duluth and Iron Range, and the Lake Superior and Southwestern. There are also located here the extensive dock of the St. Paul and Pacific Coal Company, the Lehigh Coal and Iron Company's large coal-dock, and also large coal and iron docks belonging to the Northern Pacific, and the large coal-dock now being built by the Omaha Company, besides the large merchandise dock of the Manitoba, and a large merchandise dock being built by the Lehigh Valley Transportation Company. We also have located here the International Cattle Company's Stock Yards, a corporation whose capital is $1,500,000, and which fattened at its yards and shipped the present season 3,500 stall-fed cattle, and which is continually enlarging its plant. The growth of West Superior during the past year has shown an increase of 500 per cent. in both population and buildings, and a street railway is now being built, and arrangements have been perfected for a complete system of water-works to be put in after the latest and most approved methods. The population of the place is now 4,000, with a prospect that it will more than double within the next fiscal year.

F F 3.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

This work is located about 27 miles northeast of Duluth, Minn.

The improvement has just begun, and contemplates the construction of two breakwater-piers, extending from the eastern and western points of the bay towards the center. Four hundred feet of the eastern pier will be completed during the present working season.

Agate Bay is a small indentation of the rocky coast of Lake Superior, and affords but little shelter from storms which blow on or nearly on shore, nevertheless the slight protection it naturally afforded was sufficient to insure its selection as a shipping point for the iron mines of the Vermillion Range, and a railroad was built from this bay to Tower, in the iron regions. Later on this railroad was extended to Duluth, and, in consequence of these railroad connections, Agate Bay (Two Harbors) has attained considerable importance as a shipping point. Naturally the development of commercial enterprises at this place has rendered the improvement of the harbor, so as to render it secure during storms from whatever direction, a necessity, and hence the present operations which have this object in view.

Whatever arguments may have been adduced for the commencement of this work apply now with even greater force, since the commerce of the place shows a most remarkable increase since the appropriation with which to commence the work became available.

It is at present the only shipping port for the immense iron-ore interests on the north shore of Lake Superior.

Its harbor opens earlier and closes later than those at the head of the lake.

It is destined to become an important harbor of refuge for all shipping which may pass up the lake to Duluth. It is connected by railroad with the great systems of roads of the West and Northwest.

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Its tributary interests are but in their infancy, and if the consequent commerce continues to increase as it has of late, the most strenuous efforts will be necessary to maintain the harbor improvement any thing near a condition abreast with the necessities of the situation.

The estimated cost of the two piers is $213,000. Of this sum, $22,500, appropriated by act of Congress approved August 5, 1886, will have been expended before the commencement of the next fiscal year (1889). It is important that the east breakwater be completed first. Its estimated cost is $91,292. Since this estimate was made, however, quite an advance in the cost of materials and labor has occurred, and at present prices it is hardly likely that this pier can be built for less than $100,000, an average of $100 per running foot. Deducting $22,500 appropriated August 5, 1886, leaves $77,500 amount required to complete this pier. This amount could be most advantageously and economically expended during the next year.

A tracing showing localities of proposed piers accompanies this report.

This work is situated in the collection district of Duluth, Minn. Duluth, Minn. is the nearest port of entry. The nearest light-house is situated on the south pier of Duluth Canal, Minnesota.

This is a new work, only one appropriation having been made for the improvement of this harbor, viz:

By act of Congress approved August 5, 1886	$22,500.
Amount expended under approved project to June 30, 1887	758.
Reserved by Chief of Engineers	94.
Balance available July 1, 1887	21,646.
	22,500.
Outstanding liabilities July 1, 1887	12
Estimated amount required to complete the improvement	221,70
Estimated amount required annually for preserving and maintaining, when improvement is completed	2,00

Money statement.

Amount appropriated by act approved August 5, 1886		22,50
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$853.28	
July 1, 1887, outstanding liabilities	120.00	
		9
July 1, 1887, amount available		21,5
Amount (estimated) required for completion of existing project		221,7
Amount that can be profitably expended in fiscal year ending June 30, 1889		77,5
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received for constructing five hundred linear feet, more or less, of water at Agate Bay, Minnesota, and opened March 21, 1887, at Duluth, Minn., by James B. Quinn, Corps of Engineers.

No.	Name and address of bidder.	Total for entire work proposed
1	Christian Schwarz and Charles Berner, Green Bay, Wis	

Recommended that the bid be rejected as being excessive, and that proposals be reinvited for this work. Recommendation was approved by the Chief of Engineers.

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MAP of AGATE BAY, MINN.,

howing improvements under construction and projected June 30th 1887.

Scale of Feet.

0 1 2 3 4 5 6 7 8 9 10 Feet

Notes Soundings are reduced to low water.
The portion of breakwater shown by full lines is under contract and now being constructed. The remaining portions shown by broken lines, are embraced in the project approved January 4th 1887.

To accompany annual report for 1887.

James D. Lyon
Captain of Engineers U.S.A.

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Abstract of proposals received for constructing five hundred linear feet, more or less, of breakwater at Agate Bay, Minnesota, and opened May 16, 1887, at Duluth, Minn., by Capt. James B. Quinn, Corps of Engineers.

Number.	Names and addresses of bidders.	Foundation.		Crib-work.				Total for foundation and crib-work, per running foot.
		26 feet wide, per running foot.	30 feet wide, per running foot.	Substructure 16 feet wide, per running foot.	Substructure 20 feet wide, per running foot.	Superstructure 16 feet wide, per running foot.	Superstructure 20 feet wide, per running foot.	
1	Wm. L. McLennon and Vose Palmer, Duluth, Minn	$4.77	$26.72	$15.62	$36.77	$9.28	$11.98	$25,575
2	Peter Lambert, Duluth Minn	732.04½	6,870.04½	3,835.00	9,059.00	2,180.00	4,302.00	26,988
3	Charles S. Barker, Duluth, Minn	5.25	31.50	16.50	28.50	10.50	13.25	28,425
4	Williams, Upham & Co., Duluth, Minn	5.55	33.60	17.10	30.25	10.60	14.10	30,035
5	Steele Bros. & Co., Duluth, Minn	5.27	23.90	16.64	27.20	9.25	12.48	25,306

Contract awarded to Steele Bros. & Co., as the lowest bidders for constructing 400 linear feet of breakwater, with the approval of the Chief of Engineers:

Contract dated May 18, 1887; work to be commenced on or before June 1, 1887, and completed by December 1, 1887.

COMMERCIAL STATISTICS OF TWO HARBORS, AGATE BAY, MINNESOTA.

Number of vessels arriving and departing.

Years.	Vessels.	Tonnage.
1886	*263	460,000
1885	*174	295,800
Increase	89	164,200

* In addition to these were numerous north shore and other boats, and daily boats between Duluth and Two Harbors, not included in this statement.

Receipts and shipments.

	1886.	1885.
	Tons.	*Tons.*
Ore shipped	304,396	225,484
Miscellaneous freight received and shipped	21,954	10,895
Total	326,350	236,379

Estimated value of freight received and shipped, exclusive of ore.

Years.	Value.
1886	$773,000
1885	497,800
Increase	275,200

Arrivals and clearances of vessels from May 17 to July 16, 1887, were *85; estimated tonnage, 135,326.

* In addition to these were numerous north shore and other boats calling at Two Harbors, not included in this statement.

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F F 4.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

This harbor is situated on the rocky, northern shore of Lake Superior, 110 miles east of Duluth, Minn., It is the only harbor of refuge upon this coast in the United States. Until recently it was not accessible for vessels drawing over 10 feet of water, and but little protection from southwest gales existed, but in 1883 a breakwater 350 feet long was completed, and since then some dredging has been done which has given safe anchorage space for a number of vessels of 16-feet draught.

Owing to the rapid advance in the number of vessels which pass by or visit this harbor, its importance as a harbor of refuge is greatly increasing, and it appears to be likely that in a short time the entire area of the harbor will afford but inadequate space for the accommodation of the shipping which will congregate here.

At present its chief importance lies in its being a harbor of refuge for the shipping which passes in its vicinity, but its importance as a shipping port will shortly, without doubt, be greatly increased. It is but a short distance from the marvelously rich deposits of iron ore of the Vermillion Range, and a railroad has already been projected which will start from Grand Marais and reach these mines of ore with an easier grade and less length than can be obtained from any other lake shipping port. I have been creditably informed that arrangements for the speedy construction of this road have been perfected, and that an elaborate system of ore-docks will shortly be commenced at Grand Marais.

Hardly a boat arrives in the harbor which does not bring a lot of prospectors, and hardly a day passes but some new mineral wealth is discovered, all of which but awaits the completion of the short line of road which will have its terminus at Grand Marais, to be rendered productive.

In view of the enterprises which will soon focus at Grand Marais, as a result of the completion of this railroad, it is safe to assert that the complete improvement of the harbor at Grand Marais will be necessary in a very short time.

The harbor is not very large and the convenience of commerce will require the improvement of its entire area within the 5-foot curve.

This will make it necessary to remove, by dredging, about 553,900 cubic yards of earth, at 25 cents per cubic yard, $138,475.

To afford adequate protection from the storms which come from the southwest, the further extension of the breakwater about 350 feet will be necessary. This will cost $25,000; total, $163,475.

If this sum is made available in one appropriation, which would make the success of the work certain and economical, the cost of contingencies would not exceed $2,000, or total for completed work $165,475.

If the appropriations are extended over a number of years the cost is necessarily enhanced, for the following reasons: If sufficient is not appriated to complete the pier to its full dimensions, for example, it is liable to serious damage before completion, and certain expensive precautions have to be taken which would be otherwise unnecessary. The expense of transporting the machines and appliances used in its construction will have to be added each time this transportation becomes necessary. The superintendence and other incidental expenses increase with the time the work is continued.

For similar reasons the dredging can be most economically completed in one season.

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There is, furthermore, a very great advantage to be derived from the competition of bidders when large quantities of works are involved. Economy plainly indicates that the total sum of $165,475 can be most advantageously expended during the following season.

The original estimated cost of the improvement was $139,669. This estimate did not contemplate the dredging of the entire area advocated above; in fact, it only sought to provide anchorage for vessels which might seek this harbor in stress of weather. The facilities required as a port of commerce were not contemplated. The consideration of this new exigency necessarily increases the estimated cost of the completed work.

The harbor, when completed as advocated, will contain about 50 acres of safe anchorage room. About 11 acres of this area will have been dredged by the end of this season.

The areas dredged and being dredged and the location of completed breakwater and proposed breakwater are indicated on the accompanying tracing.

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

ABSTRACT OF APPROPRIATIONS FOR IMPROVING HARBOR AT GRAND MARAIS, MINNESOTA.

By act of Congress approved March 1, 1879	$10,000.00
By act of Congress approved June 14, 1880	10,000.00
By act of Congress approved March 3, 1881	20,000.00
By act of Congress passed August 2, 1882	20,000.00
By act of Congress approved July 5, 1884	10,000.00
By act of Congress approved August 5, 1886	10,000.00
Total	80,000.00
Amount expended under approved project to June 30, 1887	68,434.60
Balance available July 1, 1887	11,565.40
	80,000.00
Outstanding liabilities, July 1, 1887	5,917.67
Original (estimated) amount required to complete the improvement	139,669.00
Present (estimated) cost to complete the improvement in accordance with extension of project, exclusive of amounts already appropriated	165,475.00
Estimated amount required annually for preserving and maintaining	1,500.00

Money statement.

July 1, 1886, amount available		$1,954.58
Amount appropriated by act approved August 5, 1886		10,000.00
		11,954.58
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$389.18	
July 1, 1887, outstanding liabilities	5,917.67	
		6,306.85
July 1, 1887, amount available		5,647.73
Amount (estimated) required for completion of existing project		165,475.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		165,475.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals received for dredging in harbor at Grand Marais, Minn., and opened December 13, 1886, at Duluth, Minn., by Capt. James B. Quinn, Corps of Engineers.

No.	Names and addresses of bidders.	Prices bid for dredging per cubic yard.
		Cents.
1	Truman & Cooper, Manitowoc, Wis	33
2	Chicago Dredging and Dock Company, Chicago, Ill	35
3	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	29
4	Renseler R. Dodge, Fulton, N. Y	39
5	Charles S. Barker, Duluth, Minn	30
6	Williams, Upham & Co., Duluth, Minn	*24½

* Lowest bid.

Contract awarded to Williams, Upham & Co., with the approval of the Chief of Engineers; contract dated December 23, 1886. Work to be commenced on or before June 1, 1887, and completed by September 1, 1887.

COMMERCIAL STATISTICS.

From January 1 to June 30, 1887:

Arrivals	63
Clearances	63
Total	126

	Tons.	Value.
Freight received:		
General merchandise	28,054	$5,926.44
Freight shipped:		
Furs	.....	1,700.00
Fresh fish	.....	700.00
Total	.....	2,400.00

Receipts and shipments of freight in 1886.

	Pounds.	Value.
Receipts	403,832	$31,014.98
Shipments	380,918	17,504.62
Total	784,750	48,519.60

Comparative statement of freight received and shipped for six years.

Year.	Pounds.	Value.	Year.	Pounds	Value.
1886	784,750	$48,519.60	1883	398,513	$27,575.04
1885	583,366	41,484.86	1882	500,000	25,691.70
1884	265,259	30,198.76	1881	362,000	30,293.00

Arrivals and clearances of vessels for six years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1886	210	210	1883	131	131
1885	188	190	1882	134	134
1884	152	158	1881	108	108

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APPENDIX G G.

HARBORS ON LAKE SUPERIOR (EAST OF SUPERIOR CITY), ON GREEN BAY, AND ON THE WESTERN SHORE OF LAKE MICHIGAN, NORTH OF MILWAUKEE, WISCONSIN.

REPORT OF CAPTAIN CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ashland Harbor, Wisconsin.
2. Ontonagon Harbor, Michigan.
3. Eagle Harbor, Michigan.
4. Establishment and maintenance of harbor-lines in Portage Lake, Michigan.
5. Marquette Harbor, Michigan.
6. Harbor of Refuge, Grand Marais, Michigan.
7. Manistique Harbor, Michigan.
8. Cedar River Harbor, Michigan.
9. Menomonee Harbor, Michigan and Wisconsin.
10. Oconto Harbor, Wisconsin.
11. Pensaukee Harbor, Wisconsin.
12. Green Bay Harbor, Wisconsin.
13. Harbor of Refuge at entrance of Sturgeon Bay Canal, Wisconsin.
14. Ahnapee Harbor, Wisconsin.
15. Kewaunee Harbor, Wisconsin.
16. Two Rivers Harbor, Wisconsin.
17. Manitowoc Harbor, Wisconsin.
18. Sheboygan Harbor, Wisconsin.
19. Port Washington Harbor, Wisconsin.

EXAMINATION.

20. Torch Lake Channel, Lake Superior, Michigan.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 27, 1887.

SIR: I have the honor to transmit herewith annual reports for the works of improvement in my charge for the fiscal year ending June 30, 1887.

* * * * * * *

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

G G 1.

IMPROVEMENT OF ASHLAND HARBOR, WISCONSIN.

By the act of August 5, 1886, $22,500 were appropriated for improving the harbor at Ashland, Wis. This appropriation was evidently made on the strength of the report of Lieut. Col. J. W. Barlow, Corps of Engineers, dated November 27, 1885. (See last Annual Report of the Chief of Engineers.)

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Supposing Colonel Barlow's project had been approved, it was proposed to commence the construction by contract of about 1,900 feet of the breakwater recommended by him, or as much as the funds would permit. This proposal was returned and orders given to prepare and submit a project with full plan and detailed estimate of cost. In an answer thereto the following letter was written:

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., September 22, 1886.

SIR: In obedience to the letter from the Chief of Engineers' Office, dated August 12, 1886, I submitted, on August 17, a project for improving the harbor of Ashland, Wis., under act of August 5, 1886, appropriating $22,500 therefor. It was proposed to expend this money in building a portion of the breakwater in accordance with the plans submitted to the Chief of Engineers by Lieut. Col. J. W. Barlow, Corps of Engineers, in his letter of November 27, 1885, the total estimated cost of which, including dredging, was $142,377.02.

This project was returned to me by indorsement dated August 28, 1886, requesting me to prepare and submit a project for the improvement, with full plan and detailed estimate of the cost of the work.

Under authority from the Department I have recently made a personal examination of Chequamagon or Ashland Bay, and before sending in any project I should like to submit the following report:

Chequamagon Bay is 12 miles in a northeast and southwest direction and has an average width of about 5 miles. It is almost completely land-locked and the only sea it is subject to originates within the bay itself, though a heavy sea outside undoubtedly raises the water in the bay during a northeaster. With a "fetch" of 12 miles, according to Stevenson's formula, we ought to have waves of about 5 feet maximum height during storms, and this corresponds closely with the heights given by those familiar with the locality. It is described as a "short, chopping sea," and, in my opinion, such seas would not have volume enough to cause the large iron-ore barges of 13 to 14 feet draught to rise and fall; doubtless much spray would be thrown and the labor of loading and unloading rendered disagreeable, but by no means impossible, on the windward side of the wharves. I inclose a map showing the general position of Chequamagon Bay, with the approximate location of the proposed breakwater shown in red. Scott's New Coast Pilot for the lakes states that "good anchorage and protection from all winds can be found almost anywhere inside of the Apostle Islands." Vessels bound east or west would not turn from their course to seek refuge in this bay, while those bound to Ashland can take refuge under Chequamic Point until after the storm subsides, as stated in the communication of the Business Men's Association of Ashland, dated August 26, 1884, and addressed to Colonel Barlow. (See Ex. Doc. No. 89, Forty-eighth Congress, second session.)

Although the proposed breakwater would be a convenience by forming a stilling basin on its lee side and would facilitate loading and unloading, I am decidedly of the opinion that it is not a necessity demanded by the general interests of commerce and I therefore recommend that this work be not undertaken.

As my opinion differs from that of Colonel Barlow, I respectfully suggest that in case the Department decides to reconsider this matter, it might refer the subject to a Board of Officers.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 13, 1886.

Respectfully submitted to the Secretary of War.

The river and harbor act approved August 5, 1886, contains the following item:

"Improving harbor at Ashland, Wis.: Continuing improvement, $22,500."

A survey of this locality was provided for in the river and harbor act of July 5, 1884, and three reports thereon have been prepared and submitted by Lieut. Col. J. W. Barlow, Corps of Engineers, two of which were transmitted to Congress and printed in House Ex. Doc. No. 89, Forty-eighth Congress, second session, copy herewith. Colonel Barlow's third and final report (also herewith) has been received since the last Annual Report of this office was submitted and has never therefore been officially communicated to Congress.

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Captain Davis, in answer to a request from this office for the preparation of a project for the expenditure of the above appropriation, reaches the conclusion that although the proposed breakwater would be a convenience by forming a stilling basin on its lee side and would facilitate loading and unloading, it is not a necessity demanded by the general interests of commerce, and therefore recommends that this work be not undertaken.

The views of Captain Davis are concurred in by this office, and it is accordingly recommended that the commencement of work upon the proposed breakwater be postponed.

JOHN G. PARKE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A., in charge of office.

[Second indorsement.]

WAR DEPARTMENT,
October 20, 1886.

Approved as recommended by the Acting Chief of Engineers.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

In March, 1887, a Board of Engineers was convened to consider the subject of the improvement of Ashland Harbor, Wisconsin, and to present a project for the same with a recommendation for the application of the available funds.

The Board submitted a report, a copy of which is attached.

The additional survey recommended by the Board was commenced early in June and was much delayed by foggy weather. At the close of the fiscal year the field-work was completed and the plotting begun. On the completion of the chart a project will be submitted for closing the breach in Chequamagon Point and dredging in accordance with the Board's recommendation.

Money statement.

Amount appropriated by act approved August 5, 1886	$22,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	679.57
July 1, 1887, amount available	21,820.43

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886.

[Furnished by C. H. Call, collector of customs, district of Superior.]

Name of harbor, Ashland, Wis.; collection district, Superior, Mich.; nearest lighthouse, La Pointe, on Chequamagon Point at entrance to Chequamagon Bay.

Arrival and departure of vessels.

	Number.	Tonnage.
Steamers	246	224,823
Sailing-vessels	276	169,718
Total	522	394,541

Principal articles of export:	Approximate value.
Iron ore	$2,290,000
Lumber	550,250
General merchandise	135,000
Total	2,975,250

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Principal articles of import:	
Coal	$55,000
Steel rails	575,000
Machinery	150,000
Hardware and general merchandise	305,000
Brick, clay, and cement	5,000
Powder	10,000
Wagons and carriages	3,000
Total	1,103,000

No revenue collected.

Mr. Call states as follows: "The arrival and departure of vessels shown are of such vessels only as report to and clear from the custom-house at Ashland, and represent about one-half of the actual number of arrivals and departures."

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 6, 1887.

SIR: I have the honor to submit herewith the report of the Board of Engineers, constituted March 1, 1887, with your sanction, upon the recommendation of this office, to consider the subject of the improvement of Ashland Harbor, Wisconsin, and to prepare a project therefor, with recommendations as to the proper application of the appropriation of $22,500 made for the improvement by the river and harbor act of August 5, 1886.

This is a new work. Chequamagon Bay, near the bottom of which the town of Ashland is situated, is about 12 miles long northeast and southwest, and about 5 miles wide. It is separated from Lake Superior by Chequamagon Point, a spit 7 or more miles long and from 200 to 1,100 feet wide, which forms the harbor, and would thoroughly protect it were it not that a troublesome sea, which originates within the bay, interferes with the security of vessels lying at the wharves.

In a report submitted November 27, 1885, giving the results of a survey made to comply with a provision of the river and harbor act of July 5, 1884, Lieutenant-Colonel Barlow recommended, for the protection of the shipping at the wharves, a jetty perpendicular to the shore, northeast of the town, to a length of 4,000 feet, or more if found to be necessary, at an ultimate cost of about $132,000, and in addition dredging an existing shoal in the harbor to the depth of 12 feet.

Under instructions from this office to prepare a project for the application of the present appropriation, Captain Davis, now in charge, reported September 22, 1886, that although a breakwater, as proposed above, would be a convenience by forming a still basin on its lee side, and would facilitate loading and unloading, he was decidedly of opinion that it is not a necessity demanded by the general interests of commerce, and therefore recommended that the work be not undertaken. This conclusion was concurred in by this office, and approved by the Secretary of War October 22, 1886.

The present Board of Engineers was convened in consequence of representations made, through Senator Sawyer and Representative Stephenson, of Wisconsin, by leading business men of Ashland, adverse to the views of Captain Davis and advocating those of Lieutenant-Colonel Barlow.

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The Board examined the locality, and after careful consideration has concluded that no breakwater, in addition to the natural one formed by Chequamagon Point, is necessary for the harbor, and recommends that the appropriation be applied to closing an existing breach on that point, and to dredging in front of the wharves at Ashland to a depth of 16 feet to accommodate the largest vessels that can pass the St. Mary's Canal.

The views of the Board are concurred in by me and recommended for approval. The preservation of Chequamagon Point appears to be of vital importance not only to the harbor of Ashland, but to all other landings in the bay. At present there is a breach one-half mile long, and of an average depth of 3 feet over it, which although as yet is said to have but little effect upon the waves of the bay, a considerable enlargement might result in carrying material in the direction of Ashland and possibly reduce the depth of water in the vicinity of the wharves.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

[First indorsement.]

Approved as recommended by the Chief of Engineers.
By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

WAR DEPARTMENT, *April* 12, 1887.

REPORT OF BOARD OF ENGINEERS.

ASHLAND, WIS., *March* 17, 1887.

SIR: The Board of Engineer officers constituted by special orders No. 35, Headquarters Corps of Engineers, Washington, D. C., March 1, 1887, to consider the improvement of Ashland Harbor, Wisconsin, and to present a project for the same, together with a recommendation for the application of the funds available ($22,500) for the improvement, has the honor to submit the following report:

The Board assembled at Ashland, March 16, and after duly considering the letter of instructions of March 1 from the office of the Chief of Engineers, as well as the papers accompanying that letter and the letter of March 2, from the same office, invited the members of the Business Men's Association of Ashland and citizens interested in the proposed improvement to present any facts in their possession bearing upon the subject. In response to this invitation a number of the Business Men's Association and others met the Board on the 17th and discussed the necessities of the harbor. But few facts, however, were presented additional to those already in possession of the Board. A written communication from a committee of the Business Men's Association, Messrs. Kennedy, Durfee, and Sampson, was received, from which it appears that the shipment of ore from Ashland for the coming season will require an equivalent of 1,200 vessels loaded with 1,000 tons each. This communication is herewith.

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The Board examined the city front, the entire bay being ice-bound, and also examined the following named, furnished by Captain Davis, Corps of Engineers:

Map of Chequamagon Bay and vicinity, scale $\frac{1}{80000}$, accompanying Colonel Barlow's report of October 21, 1884.

Map of Ashland Harbor, scale $\frac{1}{9600}$, sent to the Chief of Engineers with Colonel Barlow's report of November 27, 1885.

The first-named map is a compilation; and the second mostly a compilation, also, with the exception of the soundings.

Chequamagon Bay, on which the city of Ashland fronts, is situated about 60 miles easterly from Duluth and is a deep indentation in the south shore of Lake Superior, sheltered against storms from the lake by the group of Apostle Islands and by Chequamagon Point, a generally low and narrow sand spit, varying in width from about 200 feet to 1,000 feet, and 7 miles or more in length, on the prolongation of the main south shore of Lake Superior. Between the northwesterly end of the spit and the mainland to the west is the entrance to Chequamagon Bay, a channel about 2½ miles wide and with depths of from 30 feet to 60 feet.

The prevailing winds at this locality are from the northeast, and according to the testimony of the citizens all the storms which cause or are likely to cause damage are from that direction.

The sand-spit forms a natural breakwater against storms from the northeast, while the Apostle Islands afford almost equally good protection against storms from a more northerly direction, though the fetch of sea from this latter quarter through which waves can form to act against the Ashland wharves is longer than that within the bay from the northeast. On the Lake-Survey Chart published in 1873 the spit is clearly shown as entirely above water and connected with the mainland to the east. At the present time a breach, said to be about one-half mile in length with an average depth of 3 feet, exists in the spit, the breach commencing at a point about 1½ miles from the east shore line.

Chequamagon Bay, running northeast and southwest, is practically a land-locked harbor about 12 miles in length with an average width of 5 miles, and with depths of 18 feet to 60 feet, decreasing to less than 5 feet at the south end of the bay and to 10 feet to 14 feet in front of the wharf-heads at Ashland.

It is stated that the rate of shoaling at the south end of the bay is increasing. As to the causes of the shoaling local opinions differ, some ascribing the shoaling to the effect of waves from Lake Superior entering the breach in Chequamagon Point; others to the material brought into the bay from its numerous tributary streams, due to the rapid washing away of their banks following the deforesting of their basins by lumbermen, and, added to this, deposits, more or less, of sawdust from the saw-mills of the locality.

In the opinion of the Board the breach in Chequamagon Point has not as yet assumed sufficiently large proportions to enable waves entering it from Lake Superior to seriously affect the depths in the bay. A glance at tracing No. 1, herewith, will show that sand has undoubtedly, and for long periods, been carried into the bay around the point and thence swept under its lee.

The breach in Chequamagan Point is reported to vary in extent, sometimes increasing under the action of waves and at other times filling up from accretions of sand.

As the point where the breach occurs is low the appearance of the

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breach, as to dimensions, undoubtedly depends much upon the stage of water or height of waves existing at the time of examination.

The rate of erosion in the breach, as well as that of shoaling in the bay, if shoaling exists, can only be determined by a number of surveys from which to make comparative maps. As it is, the Board only has access to the Lake Survey chart published in 1873, scale $\frac{1}{400000}$, and the soundings over a very limited area made in 1885; insufficient for purpose of comparison, and no soundings whatever of the breach.

It is evident, however, that the preservation of Chequamagon Point is of vital importance, not only to the harbor of Ashland, but to all other harbors or landings on the bay.

HISTORY OF EXAMINATIONS AND SURVEYS OF THE HARBOR OF ASHLAND WITH A VIEW TO IMPROVEMENT.

In 1879 the harbor was examined in accordance with the provisions of the river and harbor act of Congress, approved March 3 of that year. Major (now Lieutenant-Colonel) Robert Corps of Engineers, who made the examination, reported under date of December 13, 1879, as follows:

I do not see that the harbor needs any improvement. Three years ago I examined this same question, and could not then find any necessity for any improvement by the United States. If, in the future, it should be found that the cut through the spit continues to increase to any extent, it might be advisable to consider the expediency of trying to stop this increase.

In the report of Mr. Schermerhorn, assistant to Colonel Robert in this examination, it is stated that a breach made through the spit in 1873, during a severe northerly gale, had increased by 1879 to a length of about one-half mile, and also that—it had been reported—the spit near its eastern end had, in past times, been artificially opened for the purpose of moving rafts of timber from the lake into the bay.

In 1884 a preliminary examination of the harbor was made by Lieut. Col. J. W. Barlow, Corps of Engineers, in accordance with the provisions of the river and harbor act approved July 5, 1884. In his report, October 21, of that examination he states the population of Ashland as exceeding 4,000, with a large and rapidly increasing business, four lines of railroad entering the city, and the commercial conditions differing materially from those of 1879. Colonel Barlow says in this report:

It is stated by the residents of the place that a troublesome sea in northeast storms seriously inteferes with the security of vessels while lying at the wharves.

This sea probably originates within the bay, but may be somewhat augmented by the swell which passes around the point from Lake Superior. The construction of a jetty northeast of the town, extending from the shore 4,000 feet or more into the bay, is desired by those interested as a means of preventing this disturbance. In my opinion such a jetty would have a beneficial effect.

* * * * * * *

The opening through Chequamagon Point has at present but little effect upon the wave disturbance in the bay; but a considerable enlargement, however, might result in a current which would carry material in the direction of Ashland, and possibly reduce the depth of water in the vicinity of the wharves. When this contingency becomes imminent, means of protection should be adopted.

It is stated that a break through this point has occurred and refilled by natural causes, on several different occasions, within the remembrance of persons living in the neighborhood, and that at no time has the opening reached serious proportions. Another source of annoyance to the shipping interests is a long, narrow shoal, having over it about 11 feet depth of water, and extending in a direction parallel to the shore. It lies about opposite the middle of the town, and is in the track of vessels approaching the principal wharves.

Whether this shoal was there originally or has formed within a recent period, is uncertain, as statements on this point are conflicting.

A further report by Colonel Barlow, dated January 1, 1885, considered as the improvement desirable for the harbor a breakwater, to be

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located northeast of the wharfage, extending at right angles to the shore, and the removal of a shoal lying in front of the principal wharves.

Colonel Barlow's final report, dated November 27, 1885, upon the full survey of the harbor, recommended:

(1) The location of a breakwater of piles and slabs, about 8,000 feet in length and on a line commencing at a point on the shore of Chequamagon Bay, northeast of the city and 10,000 feet beyond the ore dock of the Milwaukee, Lake Shore and Western Railroad Company, the axis of the breakwater to be nearly normal in direction to the shore-line, as indicated on the map accompanying that report.

(2) Removal by dredging of the shoal in front of Mueller & Ritchie's wharf to afford 12 feet of water.

Estimated cost of the proposed breakwater	$132,377.02
Estimated cost of the proposed dredging	10,000.00
	142,377.02

Assistant Engineer H. N. Babcock, in his report of November 25, appended to Colonel Barlow's report of November 27, 1885, says:

> There is a small shallow breach through the east end of the sand-spit, which is unimportant at present, and there is no evidence that it is enlarging.

The river and harbor act of Congress approved August 5, 1886, appropriated for "Improving harbor at Ashland, Wis.; continuing improvement, $22,500."

Captain Davis, Corps of Engineers, who succeeded Colonel Barlow in charge of Ashland Harbor, reported his opinion under date of September 22, 1886, and after a personal examination of the harbor, that the proposed breakwater was not a necessity demanded by the general interests of commerce, and therefore recommended that the work be not undertaken, principally for the reason that the waves in Chequamagon Bay were not of the size or character to render them dangerous to vessels lying at the docks.

A glance at tracing No. 2, herewith, shows that a breakwater of the length and located as proposed in the report of 1885, or one parallel to it and located anywhere between the ore-dock and Chequamagon Point, would not afford protection to the wharves of Ashland as against storms from a northerly direction, the extent of shore to be thus protected by the proposed breakwater being but little more than half the distance from the breakwater to the ore dock. A branch to the proposed breakwater commencing at its outer end and running southwesterly, or generally parallel to the shore, for several thousand feet, would form with the proposed breakwater a stilling basin, and also protect a larger extent of shore against the effect of northerly gales, though this protection would not extend to the present wharfage of Ashland. But the heavy storms, those which are likely to cause damage, are from the northeast.

The staunch ore dock of the Milwaukee, Lake Shore and Western Railway Company, about 1,400 feet long and rising to a height of nearly 40 feet above the water-surface, sufficiently protects the present wharf-front of the city of Ashland against northeast storms. As to the movement of sand along the bottom of the bay from the northeast, believed by some of the citizens to exist and to be due to the breach in Chequamagon Point, and to arrest which was one of the reasons presented in favor of the proposed breakwater, the Board is not at present prepared to regard it as existing to any appreciable extent.

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At the time of the Board's visit to Ashland the Milwaukee, Lake Shore and Western Railroad Company was building a second ore dock about 150 feet to 200 feet northeast of, parallel to, and to be 5 feet higher than its present dock; and a similar dock was in progress of construction by the Wisconsin Central Railroad Company further up the bay.

The lowest (most northeasterly) ore-dock will bear the brunt of waves from the northeast, but the railroad company has not, so far as the Board is informed, experienced any great inconvenience from such waves.

An extension of the city front beyond the Milwaukee, Lake Shore and Western Railroad Ore-dock would bring the wharves of this extension nearer to the shelter of Chequamagon Point.

As to the height of waves within the bay, if we apply Stevenson's formula, $h=1.5\sqrt{D}$, D representing the fetch of open sea, we might expect for the greatest height of waves at the ore-dock due to northeast winds, 4½ feet, to be augmented somewhat by waves from Lake Superior passing around the end of Chequamagon Point, the waves from the lake, however, rapidly reducing after passing the point and entering the expanse of Chequamagon Bay.

The height of the waves again is effected by the rise or piling up of water in the bay, under northerly or northeast winds.

The Board saw frozen spray on the outer end of the ore-dock at a height of about 8 feet above the level of the bay, undoubtedly due to the late fall or early winter gales, but spray is a different thing from solid water.

It is stated in the communication from the committee of the Business Men's Association herewith that very heavy storms wash completely over the highest merchandise docks, and at times saw-logs measuring 2½ feet in diameter have been washed up so as to lodge on docks standing 7 feet above the water—low water meant, of course. Also that such storms are liable to cause damage not only to the shipping at the docks, but to the docks themselves and the merchandise and lumber piled on them.

The damage to private wharves and merchandise located upon them seems to have been due to the method of construction of the wharves themselves; the wharves are generally flimsily built and not rising more than 6 to 7 feet above the surface of the water in calm weather.

During storms the water level of the bay is sometimes raised 3 feet by the swell from Lake Superior, so that at such times waves of but 3 to 4 feet in height dash over the wharves. The wharves should be higher and stronger than now built.

As the ore-docks will sufficiently protect the wharves under their lee against northeast storms, the position for a breakwater to protect the wharves against the longest fetch of sea, and at the same time cover the pier-heads or wharf-line from the northeast would be somewhere within the space bounded by the lines A B and A C, the latter probably an approximation to the position of the channel in front of the wharf-line to be eventually established at Ashland, and occupying some such position as D E. (Please see tracing No. 1.) Such a breakwater would not only be very expensive, owing to its length and the great depth of water within the space B A C, but it would crowd the harbor, and prove an injury rather than a benefit. And the further down the bay such a breakwater is located the greater its cost.

It is the opinion of the Board, therefore, that no breakwater in addition to the natural one formed by Chequamagon Point is necessary for Ashland Harbor.

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Ashland Harbor is already one of the most important shipping points on Lake Superior, and its facilities for commerce should be made commensurate with the capacity of the lock at the Sault Ste. Marie, which provides for the passage of vessels drawing 16 feet. The harbor should be deepened by dredging to the necessary distance beyond the wharf-line to provide for the free passage of vessels drawing 16 feet.

PROJECT AND RECOMMENDATIONS.

The Board respectfully submits as a project for the improvement of Ashland Harbor the preservation of Chequamagon Point and dredging to the necessary distance in front of the wharves to provide for vessels drawing 16 feet of water, and recommends that the $22,500 for the improvement of the harbor made by act of Congress approved August 5, 1886, be applied to closing the existing breach in Chequamagon Point, and in dredging, so far as the funds will admit of.

The maps at the disposal of the Board are not in sufficient detail to admit of any estimate being made of the cost of the dredging required, or of closing the breach in Chequamagon Point, though it is believed that the funds available will be sufficient after closing the breach to undertake the work of dredging. Additional surveys, however, are necessary in order to determine the cost of either item.

The tracings herewith are from blue-print copies of the maps accompanying Lieutenant-Colonel Barlow's reports of 1884 and 1885, dotted red lines having been added by the Board for purposes of illustration.

Respectfully submitted.

CHAS. J. ALLEN,
Major of Engineers.
D. W. LOCKWOOD,
Captain of Engineers.
WM. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF COMMITTEE OF THE BUSINESS MEN'S ASSOCIATION OF ASHLAND, WISCONSIN.

ASHLAND, WIS., *March* 17, 1887.

GENTLEMEN: The prevailing winds on this (Ashland) Bay are from the northeast. All the storms which cause or are likely to cause damage come from that direction. Very heavy storms wash completely over our highest merchandise docks, and at times saw-logs measuring 2½ feet in diameter have been washed up and lodged on docks standing 7 feet above the water. Storms of this violence are not frequent, and when they occur are liable to cause damage not only to the shipping at the docks but to the docks themselves and the merchandise and lumber piled upon them.

During last October a storm of this kind occurred, doing much damage to docks and precipitating many thousand feet of lumber into the water. When the velocity of the wind is much less it raises sufficient sea to make it impossible for vessels to lay on the windward side of our dock to load. This is very annoying, and causes great loss to shippers.

The output from our ore-docks last season was upwards of 790,000 tons, in addition to which was some 50,000,000 feet of lumber, besides other merchandise. The minimum estimate of output of ore for the coming season is 1,200,000 tons, which alone would require 1,200 vessels to transport, estimating the cargoes at 1,000 tons each. This in addition to the lumber, which this season will amount to at least 75,000,000 feet, and other products transported, furnishes business for a large fleet, which is much increased by the regular passenger and freight boats that stop at this port.

These items are mentioned to show how rapid the increase of commerce in our harbor is likely to be and the great importance of immediately improving and protecting it; and this can be done without a very great outlay of money to make it perfectly secure as a harbor of refuge, it being easily accessible in any weather, and be also so pro-

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tected that the transferring of freight from dock to vessel, or the reverse, could proceed without interruption in all weathers.

These matters have been brought by our citizens to the attention of our Senators, Hons. Philetus Sawyer and John C. Spooner, and our Representative, Hon. Isaac Stephenson, and also to the attention of the Postmaster-General, William F. Vilas, all of whom are familiar with our harbor, its importance and necessities, and through their influence an appropriation of $22,500 was secured in the river and harbor bill of 1886. An additional appropriation of $10,000 was made by the last Congress; but the bill, as you are aware, failed to become a law for the want of the signature of the President.

In consideration of the above premises, we would, as representatives of the Business Men's Association and of the citizens of Ashland, ask, as a matter of justice, that the appropriation above mentioned be expended for the purpose for which it was originally intended, to wit:

In commencing the necessary breakwater or jetty at as early a day as practicable. The necessary dredging to reach the private docks can be done, for the present at least, by individual enterprise; but the breakwater, being a matter of general interest not only to our citizens but to the lake marine, should be built at Government expense.

With the facts before you, and having yourselves made a personal examination of the location, we trust that you will make such recommendations to the War Department as shall secure to us the best results obtainable from the amount appropriated.

Very respectfully,

D. A. KENNEDY,
W. R. DURFEE,
D. G. SAMPSON,
Committee of Business Men's Association.

Major ALLEN and Captains LOCKWOOD and MARSHALL.

G G 2.

IMPROVEMENT OF ONTONAGON HARBOR, MICHIGAN.

Original estimates (see Report of Chief of Engineers, 1867, page 65).....	$363,770
Appropriated.....	285,600

The first appropriation for the improvement of this harbor was made in 1867.

The project consisted in the construction of two parallel piers 250 feet apart, extending to the 18-foot contour, and dredging a channel between them 12 feet in depth, connecting the deep water in the lake with the deep water in the river. The contemplated length of the east pier was 2,340 feet, and of the west pier 2,160 feet. At the end of the fiscal year under consideration there had been completed 2,265 feet of the east pier and 2,375 feet of the west pier, except additional filling and planking of cribs Nos. 21 to 31, and the outer 100 feet which is lacking the superstructure; 10,546 cubic yards of material had also been removed by dredging.

As stated in the last annual report, the examination of this harbor in June, 1885, indicates that owing to the advance of the bar a considerable extension of the piers will be required to reach the 18-foot contour; this, with the additional dredging required to make the 14-foot channel, will increase the original estimate $26,000.

Under the appropriation of $13,000 made by act of Congress approved August 5, 1886, after due advertisement, proposals were received for the construction of four cribs, each 50 by 20 by 12½ feet, and 100 linear feet of superstructure.

The contract was awarded to the lowest bidder, Mr. A. S. Bretherton, of Jackson, Mich.

After considerable delay Mr. Bretherton declined to enter into contract, and it was then awarded to Mr. W. T. Casgrain, of Milwaukee, Wis., the next lowest bidder.

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It was intended to complete the superstructure during the working season of 1886, but the date of Mr. Casgrain's contract, November 11, rendered it too late to begin work on Lake Superior, and actual operations did not commence until May 26, 1887. At the close of the fiscal year Cribs 34 and 35 of the west pier had been leveled, preparatory to building the superstructure upon them, the stone foundation for three cribs laid, and crib building commenced, though none were entirely completed.

It is proposed to extend the east pier 50 feet, and the west pier 150 feet, under this contract.

Minor repairs to the east and west piers, by hired labor and open purchase, are in progress.

The work contemplated during the fiscal year ending June 30, 1889, should an appropriation be made, will consist in further pier extension and probably some repairs.

This harbor derives its chief importance from the fact that it affords the only available refuge for vessels in stress of weather along the south shore of Lake Superior between the Apostle Islands and Keweenaw Point, a distance of 120 miles. It is also a port for a large back country, and has considerable local commerce. It is desirable to complete the work as soon as possible and in accordance with the original plan, except that the depth between the piers should be made at least 14 feet, instead of 12 feet as there provided for.

Money statement.

July 1, 1886, amount available	$2,225.30
Amount appropriated by act approved August 5, 1886	13,000.00
	15,225.30
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	514.25
July 1, 1887, amount available	14,711.05
Amount (estimated) required for completion of existing project	78,170.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	60,000.00
Submitted in compliance with the requirements of section 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received and opened September 24, 1886, for extension of piers and construction of superstructure at Ontonagon Harbor, Michigan.

Articles.	Quantity required.	1. John H. Gillett, Marquette, Mich.*	2. A. S. Brotherton, Jackson, Mich.†	3. Wm. T. Casgrain, Milwaukee, Wis.
Pine timber, 12 by 12 inches and 12 by 18 inches, per linear foot	7,400 linear feet	$0.35	$0.39	$0.38
Hemlock timber, 12 by 12 inches and 12 by 18 inches, per linear foot	8,000 linear feet	.35	.39	.38
Pine plank, per M, B. M.	12,000 feet, B. M.	20.00	15.00	25.00
Wrought iron drift-bolts, per pound	13,400 pounds	.06	.04	.04½
Wrought iron screw-bolts, per pound	2,600 pounds	.06	.05	.06
Wrought iron spikes, per pound	600 pounds	.06	.04	.04
Stone, per cord	540 cords	12.00	10.00	10.00
Relaying pine plank, per M, B. M.	5,000 feet, B. M.	8.00	17.00	10.00
Total amount of bid		13,146.00	12,361.00	12,385.00

* Informal. Names of guarantors not written in.

† Informal. No guaranty accompanying bid. Informality waived and bid accepted. Declined to enter into contract, and contract awarded to William T. Casgrain, the next lowest bidder.

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COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Ontonagon, Mich.; collection district, Superior, Mich.; nearest light-house, Ontonagon, Mich.

(1) Amount expended to June 30, 1887 ..... $270,888.95
Amount required to complete improvement 78,170.00
Annual cost of preserving and maintaining 11,200.00

(2) Amount of commerce and navigation when work of improvement began in 1867:

During the fiscal year ending June 30, 1867, the number of vessels arriving was 224; the number leaving, 225.

The exports and imports for the same period were as follows:

EXPORTS.

Copper	tons..	1,500
General merchandise	do...	380
Lumber	feet, B. M..	125,000

IMPORTS.

Flour	barrels..	4,790
Grain	bushels..	19,300
General merchandise	tons..	2,283

(3) Amount of commerce and navigation at present time:

STATISTICS OF COMMERCE FOR CALENDAR YEAR, 1886.

Arrival and departure of vessels.

	Number.	Tonnage.
Steamers	160	103,000
Sailing vessels	30	15,000
Total	190	118,000

PRINCIPAL ARTICLES OF EXPORT AND IMPORT.

EXPORT.

	Approximate value.
Lumber	$300,000
Copper	85,000
General merchandise	10,000
Fish	1,400
Total	396,400

IMPORT.

General merchandise	150,000
Grain	10,500
Flour	16,000
Provisions	3,300
Coal	1,200
Total	181,000

Amount of revenue collected, none.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation:

At present there are no competing routes, there being but one railroad, that of the Ontonagon and Brulé Company, a short line running from Ontonagon to Rockland, 12 miles distant; an outlet for the product of the copper mines.

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The opening up of the Gogebic iron range in Ontonagon County will undoubtedly result in building one or more through lines to Ontonagon.

The effect on rates of freight and insurance has been that due to a deepening from 7 to 12 feet and the use of this harbor as a refuge in case of storms.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement:

This harbor derives its chief importance from the fact that it affords the only available refuge for vessels in stress of weather along the south shore of Lake Superior between the Apostle Islands and Keweenaw Point, a distance of 120 miles. It is also a port for a large back country and has considerable local commerce.

G G 3.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN.

Modified estimate (see Report of Chief of Engineers, 1876, II, 328; 1877, I, 98, II, 845)	$97,000
Appropriated	97,000

The project for the improvement of this harbor was adopted in 1866 and modified in 1868, 1874, and 1878. Previous to the improvement the entrance was obstructed by a rocky reef having about 9 feet of water over the shoalist point.

The original plan of improvement contemplated the excavation of a channel across the ledge of rock to a depth of 14 feet and a width of 80 feet, and the construction of a breakwater of crib-work 20 feet wide, closing the opening of the harbor from 1,500 to 220 feet, thus leaving space for the further widening of the channel. The estimated cost of this improvement was $273,362.36 At this time the opening of copper deposits made the prospective commerce quite large, but the subsequent discovery of richer veins at other points caused the commerce to remain stationary.

The plan as finally carried out consisted in blasting and dredging a channel 130 feet wide and 14 feet deep through the reef, and marking it by two guiding-cribs, one on each side of the channel, at an estimated cost of $97,000.

The work was completed in 1879, and meets present demands of commerce. There were no operations during the past fiscal year.

No money is asked for the fiscal year ending June 30, 1889, as the balance of funds on hand will be sufficient to preserve the cribs and channel.

	Feet.
Length of east pier June 30, 1887	48
Length of west pier June 30, 1887	98

Number of cubic yards of rock removed to June 30, 1887, 3,820, prism measurement.

Money statement.

July 1, 1886, amount available	$2,886.33
July 1, 1887, amount available	2,886.33

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Eagle Harbor, Michigan; collection district, Superior, Michigan; nearest light-house, Eagle Harbor, Michigan.

(1) Amount expended to June 30, 1887	$94,113.67
Annual cost of preserving and maintaining	500.00

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The project for improvement was completed in 1879 and meets the present demands of commerce.

No appropriation is asked for this harbor, as the funds on hand will probably be sufficient to cover the expenses of keeping the channel and piers in good condition for several years.

(2) The amount of commerce and navigation when work of improvement began in 1867:

No statistics could be obtained. Before being improved the entrance to this harbor was obstructed by a rocky reef with 9 feet of water over it. A channel 130 feet wide and 14 feet deep was blasted through the rock, and a guiding-crib built on each side to mark the channel.

(3) Amount of commerce and navigation at present time:

STATISTICS FOR CALENDAR YEAR 1886.

Principal articles of import:

	Approximate value.
Coal	$45,000
Lumber	8,000
Total	53,000

Principal articles of export:

Copper	450,000

(4) The effect, if any, of work thus far executed upon rates of freight and insurance, and also upon the rates of competing routes of transportation:

Eagle Harbor has no railroad, being a small place of but 200 inhabitants, and the only effect of the improvement is to facilitate the local commerce, which, owing to copper deposits, at one time bid fair to be very large, but the opening of richer veins at other points has caused the business of this place to remain stationary.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement:

The improvement is completed, and meets present demands.

G G 4.

ESTABLISHMENT AND MAINTENANCE OF HARBOR-LINES IN PORTAGE LAKE, MICHIGAN.

The river and harbor act of August 5, 1886, contained the following clause:

SEC. 2. That in places where harbor-lines have not been established, and where deposits of débris of mines or stamp works can be made without injury to navigation, within lines to be established by the Secretary of War, said officer may, and is hereby authorized to, cause such lines to be established; and within such lines such deposits may be made, under regulations to be from time to time prescribed by him.

In accordance with this authority the Secretary of War referred the matter to the consideration of a Board of Engineer Officers, convened August 13, 1886, and, agreeably to its recommendation, "rules and regulations for the establishment and maintenance of harbor-lines in Portage Lake, to prevent the destruction of the through routes of communication across Keweenaw Point," with an accompanying chart showing the location of the lines, were printed and widely distributed.

No infraction of the regulations had been reported at the close of the fiscal year.

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REPORT UPON THE LIMITING SHORE-LINES PROPOSED AT PORTAGE LAKE, MICHIGAN.

ARMY BUILDING,
New York, December 22, 1886.

GENERAL: In accordance with your instructions of October 30, 1886, the Board of Engineers constituted by Special Orders, No. 112, current series, Headquarters Corps of Engineers, has the honor to submit the following special report upon the limiting shore-lines proposed at Portage Lake, to prevent the destruction of the through route of communication across Keweenaw Point, by deposits from the copper stamp-mills in that vicinity.

The language of section 2 of the river and harbor act of August 5, 1886, is as follows:

> That in places where harbor lines have not been established, and where deposits of débris of mines or stamp works can be made without injury to navigation, within lines to be established by the Secretary of War, said officer may, and is hereby authorized, to cause such lines to be established; and within such lines such deposits may be made, under regulations to be from time to time prescribed by him.

This subject has been discussed in a general way in the report of the Board upon the proposed opening of the Portage Lake route to the commerce of Lake Superior, dated December 22, 1886, and the limiting shore-lines regarded as essential to preserving the value of this waterway as a great National through route for commerce have been indicated upon map No. 2, accompanying that report. In recommending the establishment of these lines the Board has been governed by the following conditions:

Nature has provided a spacious and safe channel at this place, where it is needed not only for the commerce of Houghton and Hancock, but also as a free passage for the great fleets of vessels now engaged in the general commerce of Lake Superior. These stamping-mill deposits have already made serious encroachments upon the free water-way, and unless immediately checked must soon destroy it, as is apparent from the map above mentioned. If, as seems probable, the Government is soon to assume control of this route, action under the law above quoted cannot be too soon taken by the Department. The Board is satisfied that public opinion in the vicinity will sustain such action; indeed, we are informed that the passage of the law was urged with this special object in view. For previous action reference is made to the report of Major Robert, printed as House Ex. Doc. No. 85, Forty-seventh Congress, second session.

The natural width of channel in the vicinity of Houghton and Hancock is 1,000 feet. This full width, none too much for free passage of the Lake Superior tows, is also necessary for the local traffic, because steamers require at least three times their length to turn readily, and the length of the larger class now exceeds 330 feet. Many of the steamers engaged in local traffic discharge their freights at docks on both sides of the lake, and are therefore compelled to turn frequently. Hence the Board has adopted parallel shore-lines 1,000 feet apart, between which obstructions of the channel should not be permitted. Nature has granted this width and it should not be sacrificed for individual gain. The only exception has been made for a length of about 2,100 feet between the bridge and the Pewabic Dump, where, to avoid serious interference with existing wharves, the width has been reduced to 900 feet.

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The Board appends to its report a letter from Mr. James Pryor, superintendent of the Lake Superior Ship Canal and of the Portage River Improvement Company, setting forth the needs of local commerce in this matter. The needs of through commerce will be still greater if, yielding to the urgent wishes of the general navigation interests of the lakes, the Government assumes the expense of opening this route across Keweenaw Point to the largest class of shipping navigating Lake Superior.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
O. H. ERNST,
Major of Engineers.
CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 8, 1887.

SIR: To enable a compliance with the requirements of section 2 of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report upon the limiting shore-lines proposed at Portage Lake, Lake Superior, to prevent the destruction of the through water route across Keweenaw Point, by deposits from the copper stamp-mills in that vicinity, which has been received from the Special Board of Engineers constituted under section 5 of the same act; together with a map, upon which are marked the lines recommended by the Board to be established, within which such deposits may only be made.

The lines therein designated are recommended for approval, and, with your sanction, the officer in charge of that district, Captain Davis, will be instructed from this office to see that their establishment is enforced under such regulations as may be determined upon.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

[1st indorsement.]

WAR DEPARTMENT,
January 19, 1887.

Respectfully returned to the Chief of Engineers, approved as recommended.

By order of the Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

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REGULATIONS FOR THE ESTABLISHMENT AND MAINTENANCE OF HARBOR-LINES IN PORTAGE LAKE, TO PREVENT THE DESTRUCTION OF THE THROUGH ROUTES OF COMMUNICATION ACROSS KEWEENAW POINT.

[Approved and ordered by the Secretary of War March 16, 1887.]

AUTHORITY.

Section 2 of the river and harbor act of August 5, 1886, reads as follows:

"That in places where harbor-lines have not been established, and where deposits of débris of mines or stamp works can be made without injury to navigation, within lines to be established by the Secretary of War, said officer may and is hereby authorized to cause such lines to be established, and within such lines such deposits may be made under regulations to be from time to time prescribed by him."

This subject having been referred to a Board of Engineer officers constituted by Special Orders, No. 112, current series, Headquarters Corps of Engineers, August 13, 1886, the harbor-lines recommended by that Board are hereby established as follows:

HARBOR LINES.

Commencing 1,600 feet, more or less, to the westward of the Atlantic mill, on the south shore of Portage Lake, a harbor-line shall be established on each shore, said lines to be parallel to each other and 1,000 feet apart, each following the curves and bends of the river and being generally tangential to the shore-line.

This width of 1,000 feet between the harbor-lines shall be maintained until abreast of the Quincy Mill, or about 1,000 feet to the westward of the railroad and viaduct bridge connecting the towns of Hancock and Houghton, at which point the northern harbor-line shall approach the southern one gradually, narrowing the distance between the two lines from 1,000 feet to 900 feet at the above-mentioned bridge, this narrowed width of 900 feet being maintained from the bridge eastward for about 2,100 feet, at which point the line marking the northern harbor limit shall gradually separate from that of the south shore until the original interval of 1,000 feet is reestablished at a point about 400 feet, more or less, to the eastward of the Franklin Mill, and thence these lines shall continue parallel and 1,000 feet apart for a distance of 10,000 feet, more or less, to where the lake begins to widen out. All as marked and laid down on Sheet No. 2, map of part of Portage Lake, in vicinity of Houghton and Hancock, Mich., from surveys made in October and November, 1886, under the direction of the Board of Engineers constituted by Special Orders, No. 112, Headquarters Corps of Engineers, United States Army, Washington, D. C., August 13, 1886.

RIPARIAN OWNERS.

On each side of Portage Lake, between the shore and its corresponding harbor-line, as set forth and described in the preceding paragraph, riparian owners may erect, build, and maintain docks, wharves, and other structures, and may deposit the refuse, débris, tailings, or products of stamp-mills, but no person whatever shall be permitted to erect, build, or maintain any dock, wharf, or other structure, or to deposit the refuse, débris, tailings, or products of any stamp-mill beyond said limits as defined in the preceding paragraph.

PENALTY.

Any person who violates any of the above regulations, by erecting or attempting to erect or maintaining any dock, wharf, or other structure, or by dumping or attempting to dump any refuse, débris, tailings, or products of any stamp-mill, outside of or beyond the above-described harbor-lines, shall, on conviction thereof, be punished by a fine not exceeding $1,000.

REPORT UPON THE EXPEDIENCY OF THE ACQUISITION BY THE GOVERNMENT OF THE PORTAGE LAKE AND RIVER IMPROVEMENT COMPANY CANAL, AND THE LAKE SUPERIOR SHIP-CANAL RAILWAY AND IRON COMPANY CANAL, IN THE STATE OF MICHIGAN.

WAR DEPARTMENT,
Washington City, January 24, 1887.

The acting Secretary of War has the honor to transmit to Congress, in compliance with the requirements of the river and harbor act of August 5, 1886, a letter of the 6th instant from the Chief of Engineers, and a copy of a report, with appendices and a map from a Board of

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Engineers, constituted in compliance with the provisions of said act "to examine in all their relations to commerce the two improved water-ways known as the Portage Lake and River Improvement Company Canal and the Lake Superior Ship-Canal Railway and Iron Company Canal, being the improved harbors of refuge and the water communication across Keweenaw Point, from Keweenaw Bay to Lake Superior, by way of Portage River and Lake, in the State of Michigan, with a view to making the same a free passage-way and harbors of refuge, to consider their value and all matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement."

The Board recommends (1) that the offer of the companies be accepted to transfer all right and title to the canal; the works of improvement on Portage River; the harbor works upon Lake Superior and Keweenaw Bay, with all lands and franchises connected therewith, free from all incumbrances and involving no other payments for bonds or otherwise whatsoever, for the gross sum of $350,000; and (2) that the route be made a free water-way of the United States, subject to no tolls or assessments whatever.

In the opinion of the Board the price asked is reasonable, and the franchises now owned by these corporations have been legally and fairly acquired, but bear heavily upon commerce, and the companies are willing to yield to the popular demand for a free water-way as soon as they are protected from actual loss themselves.

Attention is called to the serious obstructions to navigation now existing in Portage Lake from mining deposits, and to existence of a low railroad bridge that would become a serious impediment to navigation should the route be further enlarged.

The Board submits estimates for a navigable depth of 16 feet with a minimum width of 70 feet, to be obtained by dredging wherever required throughout the entire extent of the water-way, and in addition, estimates for an increase, should the future needs of commerce demand it, of the navigable depth of 20 feet, with corresponding increase of width; also estimates of the cost required to provide for commerce as well as refuge enlarged and safe entrances from Keweenaw Bay and from the lake.

The conclusions and recommendations of the Board are concurred in by the Chief of Engineers and by the Department.

S. V. BENÉT,
Brig. Gen., Chief of Ordnance,
and Acting Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 6, 1887.

SIR: I have the honor to submit herewith a copy of the report, with appendices and a map, received at this office December 23, from the Board of Engineer Officers constituted in compliance with the following provision of the river and harbor act of August 5, 1886, viz:

That the Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army, whose duty it shall be to examine, in all their relations to commerce, the two improved water-ways known as the Portage Lake and River Improvement Company Canal and the Lake Superior Ship-Canal Railway and

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Iron Company Canal, being the improved harbors of refuge and the water communication across Keweenaw Point, from Keweenaw Bay to Lake Superior, by way of Portage River and Lake, in the State of Michigan, with a view to making the same a free passage-way and harbors of refuge, to consider their value and all other matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement. The said Board shall report to the Secretary of War, who shall lay its report before Congress, at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon.

The Board, after careful consideration of the subject in all its bearings, and in the light of all the information it has been able to collect, recommends (1) that the offer of the companies be accepted to transfer all right and title to the canal; the works of improvement on Portage River; the harbor works upon Lake Superior and Keweenaw Bay, with all lands and franchises connected therewith, free from all incumbrances and involving no other payments for bonds or otherwise whatsoever, for the gross sum of $350,000; and (2) that the route be made a free water-way of the United States, subject to no tolls or assessments whatever.

Regarding the values of the two improvements which the companies propose to transfer to the United States for the above sum, the Board makes an exhibit of their past expenditures and receipts and concludes that the price asked is reasonable; that the franchises now owned by these corporations have been legally and fairly acquired, but they bear heavily upon commerce, and the companies seem willing to yield to the popular demand for a free water-way so soon as they are protected against actual loss themselves; and, further, that the pressure for the purchase does not originate with the owners of the property, but with the mining population and the general commerce of the lakes.

The Board calls attention to the serious artificial obstructions to navigation now existing in Portage Lake from mining deposits, and indicate certain harbor lines for approval by the Secretary of War, under section 2 of the river and harbor act of August 5, 1886, beyond which such deposits may not extend, and recommends that proper legal means be adopted for abating such infringements in the future. Attention is also called to the existence of a low railroad bridge that would become a serious impediment to navigation should the route be further enlarged.

Having caused careful examinations and surveys to be made of all parts of the route where work is likely to be required by any project for further improvement, the Board submits estimates for a navigable depth of 16 feet with a minimum width of 70 feet to be obtained by dredging wherever required throughout the entire extent of the waterway, and, in addition, estimates for an increase, should the future needs of commerce demand it, of the navigable depth to 20 feet with corresponding increase of width. Estimates are also submitted of the cost of such improvements as would be required to provide, for commerce as well as refuge, enlarged and safe entrances from Keweenaw Bay and from the lake.

Being, by the terms of the act of August 5, required to give my views with regard to the matters under consideration, it appears to be sufficient to state that the careful, thorough, and certainly disinterested treatment of the whole subject by the Board of Engineers leads me to a full concurrence in its conclusions and recommendations.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WILLIAM C. ENDICOTT,
Secretary of War.

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REPORT OF BOARD OF ENGINEERS.

ARMY BUILDING,
New York, December 22, 1886.

GENERAL: The Board of Engineers, constituted by Special Order 112, paragraph 3, Headquarters Corps of Engineers, Washington, D. C., August 13, 1886, to consider and report upon certain questions, under act of Congress approved August 5, 1886, in connection with the Portage Lake and River Improvement Company Canal, and the Lake Superior Ship-Canal Railway and Iron Company Canal, etc., Michigan, has the honor to submit the following report:

The southern shore of Lake Superior from Sault Ste. Marie on the east to Duluth on the west, a direct distance of about 375 miles, conforms in general to the 46° 30′ parallel of north latitude, but midway between the two cities the rocky promontory of Keweenaw Point projects northeastwardly into the lake, and compels vessels engaged in the coasting trade to make a wide détour. The shores of this promontory are bold, with outlying reefs, dangerous to navigation, and with no good harbors to afford refuge in storms. All important copper mines of the Lake Superior region heretofore opened lie north of the 46° 30′ parallel of north latitude, near or upon this projecting point.

About 40 miles southwest from its extremity the promontory is cut nearly in a north and south direction, by the water-way which forms the subject of this report. Its total length is 24 miles. Of this distance nature has made about 16 miles navigable for all classes of vessels through Portage Lake, which occupies a narrow and deep chasm, formed by some ancient convulsion.

Heading about 2 miles from Lake Superior on the northwest side of Keweenaw Point it extends southward, receiving from the east the overflow of Torch Lake. The natural depth of both lakes is ample for all purposes of commerce, present and prospective. The drain, by Portage River into Keweenaw Bay, the great re-entrant formed by the promontory and the southern shore of Lake Superior. The original draught which could be carried through Portage River into the lake was from 3 to 5 feet. To secure this depth on many interior rivers large expenditures are annually made by the Government.

Hancock and Houghton are the chief shipping ports of the copper industry. They lie opposite each other on Portage Lake, about 10 miles from Lake Superior. When the development of the mines had reached such a point as to render the demand for increased facilities of communication imperative, the country was upon the eve of civil war. The work was inaugurated and has been completed without assistance from the General Government.

The project of cutting a ship-canal through the ridge of sand and hardpan separating the north end of Portage Lake from Lake Superior was also formed during the war, and a company was incorporated for the purpose. The present canal has resulted, after various changes in organization, which will be considered more in detail below. The General Government has aided this part of the work by appropriating 400,000 acres of public lands. No other assistance was received from the General Government or from the State of Michigan.

These two improvements, although owned by separate corporations, are now practically controlled by the same individuals.

NATIONAL IMPORTANCE OF PORTAGE LAKE ROUTE.

Before going into details respecting the history, present condition, and present value of this water-way, its national importance will be

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considered from two points of view: That of interstate commerce and that of copper production.

Interstate commerce.—The records of the Sault Ste. Marie Canal afford precise data from which to judge of the extent and nature of the commerce of Lake Superior. The following figures exhibit the freight which has passed through the canal during the past five years:

Years.	Registered tonnage.	Actual freight.
	Tons.	*Tons.*
1881	2,092,521	1,567,741
1882	2,468,083	2,020,521
1883	2,042,259	2,267,105
1884	2,997,837	2,874,557
1885	3,035,937	3,256,628

The increase during 1886 has been enormous, and, according to present indications, will amount at the close of the season to fully 4,500,000 tons of actual freight moved almost exclusively by steam. According to the official report, the Suez Canal itself only passed 5,871,500 net tons in 1884.

There are few ports on the northern shore of Lake Superior at which our vessels find it profitable to trade. They naturally hug the southern shore, on which are situated the centers of the iron, copper, and lumber industries; where are imported immense supplies of coal, lime, building materials, machinery, provisions, and supplies of every kind, and where are exported iron, copper, and lumber. At Duluth and Superior City the exports of grain and imports of every kind needed to develop the new region opened by the Northern Pacific and other railroads swell the traffic to the enormous and increasing figures given above. Keweenaw Point, as already stated, juts far out into the lake and obstructs this natural route of trade.

Again, the prevailing storms of the Lake Superior region are from the northwest and northeast. The natural route of commerce near the southern side lies, therefore, throughout its whole extent along a lee shore. During the summer months navigation is usually safe, but in the spring, when the winter accumulations of iron, copper, and lumber demand prompt shipment, and in the autumn, when the wheat crop is pouring from the great Northwest, the lake is stormy and dangerous. Harbors of refuge are urgently needed, not only to save life and property, but also to prevent delays and afford that certainty of rapid transit upon which the low price of freights depends. A vessel liable to be compelled by an approaching storm to linger among the Apostle Islands, it may be for days, before daring to encounter the perils of rounding Keweenaw Point, "the Cape Horn of Lake Superior," must charge accordingly. The distance to be traveled before reaching the next harbor of refuge, Marquette, is fully 225 miles, and the whole commerce of Lake Superior is subjected to delays and corresponding increase of rates of freight by the lack of intermediate shelter.

The Board is under obligations to Mr. E. T. Evans, general manager of the Lake Superior Transit Company, Buffalo, N. Y., for a list of casualties on this iron-bound coast between the years 1847–1886. This document, appended, marked A* exhibits what have been the dangers in the past, and affords data for estimating what they may be expected

*Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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to be in the future, with the vastly increased shipping now engaged in the traffic. The aggregate loss already reaches two hundred lives and $2,359,340.

Portage Lake, about midway between Marquette and Ashland, would be a perfect harbor of refuge if a western entrance from Lake Superior were provided, safe to enter during storms; at present no such entrance exists.

It appears from the foregoing facts that, partly to remove the obstruction offered by Keweenaw Point and partly to secure a needed harbor of refuge, the construction of a ship-canal to perfect the Portage Lake route would now be urged by the navigation interests of the lakes, even if private enterprise, aided by the Government, had not already begun the improvement. That there is now a lively interest felt in the matter throughout the whole lake region is apparent from the communications from leading commercial organizations appended, and marked B* and C,* the former addressed to the Board, the latter received in response to a circular letter.

Copper production.—The national importance of the great copper mines of Lake Superior requires no demonstration. The Calumet and Hecla mine alone furnishes one-tenth of the world's annual production. The following official statement exhibits how rapidly the industry is developing:

Refined copper from Lake Superior mines.

Years.	Net tonnage.	Value in New York.
1855	2,904	$1,586,160
1860	6,034	2,654,960
1865	7,179	5,635,515
1870	12,311	5,096,752
1875	18,019	8,180,626
1880	24,869	9,947,673
1885	36,098	.....

By far the largest portion of this product is mined in the vicinity of Portage Lake and shipped directly from Hancock and Houghton; even the copper shipped at the small ports of Ontonagon, Eagle Harbor, and Copper Harbor is brought to the same place for smelting. The whole annual production of Lake Superior copper is thus compelled to pass through the Portage Lake route and pay a tax to the canal companies before it reaches the free waters of the United States. But this is not all. The region is productive only in minerals, and there are no manufactures. A few potatoes and a little hay form the sole crops. The food supplies and all manufactured articles for the use of a mining population of about 30,000 persons, to say nothing of the coal, lime, and other materials used in producing the copper, are received through the same Portage Lake route, and are subjected to this same tax. The recent extension of the railroad from L'Anse has not, as we are informed, afforded relief. The annual exports and imports at Houghton and Hancock are reported to the Board as probably exceeding $12,000,000, of which 95 per cent. pertains to States other than Michigan. Precise figures on which to base these estimates were not presented, but the statement was made to the Board at a public meeting of leading citizens and was indorsed by all the business men present.

There is thus presented a singular anomaly in American practice; a great national industry situated on navigable waters of the United

* Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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States, taxed for interstate commerce in the persons of every man, woman, and child engaged in the production, and taxed twice—once for the product, and once for every necessary of life.

The iron industry is not thus handicapped at the neighboring cities of Marquette and Escanaba, where good harbors have been provided by the General Government free from all charges to those engaged in the production.

HISTORY OF THE PORTAGE LAKE CANALS.

(1) *Portage River improvement.*—By the year 1859 the copper interests centering in Portage Lake had acquired an importance that rendered improved facilities for transportation a necessity. At the mouth of Portage River there was a depth of from 3 to 5 feet over the bar. Vessels arriving there were anchored in the offing, freight was transferred by lighters to docks inside the bar and there again transferred to scows, upon which it was towed to the mines, a distance of about 14 miles, at a cost of $4 per ton. The expense, delay, and annoyance attendant upon this method of procedure led those who suffered there from to attempt a remedy by dredging the river and bar and constructing a breakwater. The sum of $30,000 was raised by subscription, the contributors being the Quincy, Pewabic, Franklin, Mesnard, Pontiac, Saint Mary's, Albany and Boston, and Isle Royale Mining companies, and two merchants and land owners, Messrs. Sheldon and Douglas. Mr. John H. Forster was employed as engineer, and a contract was made with Mr. W. W. Williams for securing a channel 10 feet deep and 80 feet wide at bottom. Instead of using the original river mouth the engineer selected a point further to the east, where he laid out a breakwater and a canal leading to it through a tamarack swamp, the length of cut being 1,200 feet. The object of the breakwater was to prevent the sand moved by northeast storms from filling up the mouth of the canal. Only one pier was considered necessary. It was built during the winter of 1859–'60, the cribs being constructed upon the ice and then sunk and the stone hauled from the quarry upon sleds, the thermometer often running from 20° to 30° below zero. In the month of June, 1860, the first lake steamer was piloted through the canal and river up to the docks in Hancock, though the contract for the improvement was not completed until the autumn of that year. This work was done without the authority of law.

In the following year an act was passed by the Michigan legislature to provide for the formation of companies to construct canals or harbors and improve the same, which act was approved and became law March 13, 1861. Under this law the Portage Lake and River Improvement Company was incorporated, being composed of the persons who had begun the improvement. They were authorized to charge tolls upon all vessels drawing more than 5 feet, the rates being fixed by Houghton County.

The improvement thus far made, great as it was, was very far from being complete. Considerable sums, the exact amounts of which are known only to the company, were expended annually in maintaining and deepening the channel, straightening the river, and placing buoys and beacons. As the trade of the locality increased, greater facilities were called for in the use of the water-way. As early as 1865 a depth of 13 feet was called for. In 1874 extensive additional dredging was begun, the object being to obtain a channel depth of 13 feet. In 1875 the old pier was widened and a new superstructure constructed, the

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old foundation remaining intact then as it does now. Dredging has been continued annually. The income from tolls also increase annually, enabling the corporation to provide for these additional expenses and at the same time to have a handsome profit remaining.

In 1879 the Michigan legislature passed an act, approved May 22, under which any county in which the greater part of a canal or improved river may pass is authorized to purchase such canal or improvement, paying to the improvement company the amount of its capital stock and the amount of all subsequent expenditure in repairs and alterations, with interest at 10 per cent., but deducting from the amount of interest the net proceeds of the improvement.

Of late years pressure has been brought to bear upon the company to reduce the tolls. In 1885 the rates of toll were reduced by nearly 50 per cent. below what they had been up to that time since 1863. The demand now is that the tolls shall be removed altogether and that the water-way shall be further enlarged.* None of the original stockholders now hold any interest in the corporation, and we are informed that the property is now owned entirely by persons non-residents in the district.

(2) *Lake Superior Ship Canal, Railway and Iron Company.*—The opening of Portage Lake, by means of the improvement of Portage River, to vessels navigating Lake Superior, enabled them to go within a trifle over 2 miles of Lake Superior on the west side of Keweenaw Point. The advantage which would accrue from making the water-way continuous from the east side to the west side of Keweenaw Point was obvious, but it involved the construction of an artificial canal 2 miles long, with a breakwater at its entrance from Lake Superior. The expense of such a work was beyond the means of the persons immediately interested in the local trade of Portage Lake, and the benefits to result from it would be national rather than local, while the returns to be expected from the tolls would probably not pay interest upon the investment for many years.

A corporation entitled the Portage Lake and Lake Superior Ship Canal Company was organized under the State laws in 1864, its articles of agreement being filed with the secretary of state of Michigan July 15, 1864. By a joint resolution of the Michigan legislature dated January 21, 1865, Congress was asked to aid the enterprise by a grant of land. The Minnesota legislature passed a resolution to the same effect February 24, 1865. Congress responded by granting to the State of Michigan, by the act approved March 3, 1865, 200,000 acres of land. By act approved March 18, 1865, these lands were conferred by the State upon the above-mentioned corporation, with certain conditions. A plan of construction was then adopted, which was more expensive than had at first been contemplated. Additional aid was sought from Congress by the governor and Representatives of Michigan. The legislatures of Wisconsin and New York passed resolutions February 27, 1866, asking Congress to aid the enterprise. A number of cities also sent in petitions to the same effect. Congress again responded by granting 200,000 additional acres of land by act approved July 3, 1866.

The canal was to be 13 feet deep and 100 feet wide, and to be provided with a breakwater at its Lake Superior end. For several years operations were limited to surveying the ground, procuring machinery, and the exploration of lands to be selected under the grant. The original surveys and plans were made by Mr. I. N. Greene, engineer for the

*An interesting letter from Mr. John H. Forster, from which much of the foregoing information has been obtained, is here appended, marked D.

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State. It was not until 1868 that the work of excavation was actually begun, and at the end of that year only a few thousand yards had been excavated. In the spring of 1869 the work was resumed with great activity, and was vigorously pushed during that and the following year. Mr. John H. Forster superseded Mr. Greene as engineer for the State June 1, 1869. In 1871 the work was embarrassed for want of funds, and made unsatisfactory progress. The title of the company was altered to Lake Superior Ship Canal, Railroad and Iron Company. In this year the company failed, and a receiver was appointed by the United States circuit court in Michigan, with authority to borrow money for the purpose of completing the canal. The work advanced slowly during the two following years.

The act of Congress making the first grant of land required that the works should be completed by March 3, 1867. The act making the second grant extended this time three years, or to March 3, 1870. The time was subsequently extended to March 3, 1872, and again to March 3, 1873, and finally to December 1, 1873. On the 18th of October, 1873, the State engineer, Mr. Forster, certified that the works were completed according to law, and on the 29th of November, 1873, the governor of Michigan certified that the works were built according to law, but that the title to the lands upon which they were situated being vested in the officers of the company as individuals, and not in the company itself, he did not consider the works completed in accordance with the act of Congress. It was not until June 25, 1875, that the governor gave his final certificate that the works were completed, the delay being caused by the transfer of legal title required by him. Technically, therefore, the works were completed in 1875, but as a matter of fact they were completed in 1873.

In May, 1877, after protracted litigation, the property was sold under decree of foreclosure. It was purchased by Messrs. Mann and Wilson, for the bondholders and creditors of the old company, who organized the present company, under the title of Lake Superior Ship-Canal, Railroad and Iron Company. The consideration mentioned in the deed to Mann and Wilson was $870,000. In the deed from them to the new company the consideration was $100, subject to prior incumbrances amounting to $1,636,385 and accrued interest at 10 per cent. The present company had no connection with the old company.

This canal, independently of the lands attaching thereto, has not proved a financial success. The income from tolls has been almost wholly expended in keeping it in repair.

PRESENT CONDITION OF THE IMPROVEMENTS.

The lake survey charts of this vicinity were prepared before the improvements had been completed, and no accurate survey of the canal and Portage River improvements had ever been made. Moreover the stamp-mill deposits have largely encroached upon Portage Lake, and demand, in the interests of navigation, immediate attention. For these reasons the Board has caused to be made a careful examination and survey (with borings where necessary) of all parts of the route where work is likely to be required by any project for further improvement. This work was promptly and well done by Mr. G. A. Marr, formerly assistant engineer on the survey of the lakes, aided by an efficient party, and the results appear upon four maps, three of them drawn upon a sale of $1''=400'$, and one upon a scale of $1''=100'$. They are forwarded with this report. Mr. Marr's detailed report is appended, marked N.

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The following description of the route is based upon the notes of this survey, and upon a personal inspection made by the Board in October, 1886.

In considering the navigable depth of the canal as indicated by the soundings, oscillations of the lake surface can not be neglected. A continuous gauge record has been kept above the locks at Sault Ste. Marie since November, 1870, which shows that besides the temporary and irregular changes of level due to winds there is an annual and an abnormal oscillation. In consequence of the former the water-surface is usually about a foot higher in the months of July, August, and September than in the months of February, March, and April, the change occurring principally in the intermediate months. The gradual abnormal oscillations often cover several consecutive years, as appears from the records for sixteen years at Sault Ste. Marie, furnished by General Poe, appended, marked E.* The extreme oscillation during the fifteen years has been 3 feet, occurring between September, 1876, and March, 1880.

During the progress of the surveys ordered by the Board a daily gauge record was kept in Portage Lake. To connect this with the levels of the lake survey a comparison was made, during calm weather, on November 9, 1886, with the nearest bench-mark (at Marquette). The water there stood 601.32 feet above sea-level. The corresponding elevation at Sault Ste. Marie was 601.62. Upon this basis the average stage of water at Portage Lake during the survey was assumed at 601.4 feet above sea-level. The corresponding mean level at Sault Ste. Marie (601.62) was 0.36 foot below the grand mean for October and November during sixteen years. The maximum oscillation at Portage Lake during the survey was 0.6 foot, 0.3 foot above, and 0.3 foot below the average stand, but these readings were only temporary.

Portage Lake.—Of the 24 miles covered by this route about 16 miles traverse Portage Lake. This is a long and narrow sheet of water, with a depth usually varying from 30 to 40 feet, and presenting no natural obstacle to any class of vessels ever likely to navigate Lake Superior. The width is rarely less than 1,000 feet; the banks are usually high, affording perfect protection against gales. In a word, after an entrance has been effected, no better harbor of refuge could be desired.

Two artificial obstructions to navigation exist: A low railroad and viaduct bridge between Houghton and Hancock, with a center pivot-draw affording only 68 feet clear space; and eight projecting masses of deposit from the stamp-mills—five from the Atlantic, Huron, Franklin, Quincy, and Pewabic, now in active operation. Information upon this subject has already been called for by Congress and reported upon by Maj. H. M. Robert, Corps of Engineers, House Ex. Doc. 85, Forty-seventh Congress, second session.

The Board was informed that the second section of the river and harbor act of August 5, 1886, was urged upon Congress with special reference to abating these stamp-mill deposits, which, unless checked, must soon destroy the value of the lake as a route for through commerce. Our survey was therefore extended (Map No. 2) to cover the entire region affected by them, and proposed harbor-lines have been indicated thereon for the action of the honorable Secretary of War. The necessity of at once putting a stop to these deposits can not, in our judgment, be too strongly stated if this route is to be made a national highway for the commerce of the lakes.

* Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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Portage River.—Portage Lake is connected with Keweenaw Bay by a river now artificially shortened to about 5 miles in length (see Map No. 3). Originally it was tortuous and obstructed by two bars, one at its exit from the lake and the other at its entrance into the bay. Only from 3 to 5 feet could be carried over these bars, although for long distances the natural channel was much deeper. At present by dredging and cutting off points, a navigable and tolerably straight channel averaging over 100 feet in width, with a minimum depth of 14 feet, has been secured. The banks are low, and no revetment has been placed to preserve the cuts.

For the harbor entrance at Keweenaw Bay a single pier has been built, projecting 675 feet from the shore-line to 14 feet of water. It was originally made of a single row of timber cribs 12 feet wide, loaded with stone; but a second line was subsequently added, so that now the width is from 25 to 30 feet. While not an elegant construction, it serves the immediate needs of commerce in the comparatively sheltered position it occupies, and the Board heard no complaints as to dangers encountered at this entrance in storms.

As already stated, all the improvements in this part of the route have been made without cost to the Government, by private enterprise. No outlay has been made to secure a title to the bed of the river, but the sites of the cuts have been purchased by the company, and it is proposed to transfer a clear title to them, as set forth in the statement appended, and marked F.*

The ship-canal.—This canal is 2.1 miles long. Our soundings indicate a depth of 14 feet throughout its whole extent. The least width at water-surface is 100 feet, widening to over 200 feet in the Lily Pond, and thence maintaining 100 feet nearly to Portage Lake. The southern half (near Portage Lake) traverses a swampy region, where no especially difficult work is required for enlargement. The northern half involves more outlay in its extension through an old tamarack swamp and a range of sand ridges 30 feet high with a hardpan bottom outcropping near Lake Superior. Enlargements here would be more expensive.

Throughout the whole extent of the canal its revetment consists of a front row of piles, generally about 6 feet apart from center to center, capped a few inches above the water-surface to support a single row of sheet piling; a row of anchor piles is driven about 7 feet back and connected with the front row by timber braces. The piles seem generally to be well preserved, but the caps are often decayed and the sheet-piling requires frequent repairs to maintain it in position. The superintendent, Mr. Pryor, states that experience has shown that where the route traverses sand-hills double the number of piles should be used and a double sheet-piling should be driven. As now built, if the space behind is solidly packed the piles are pressed out of position; if it be left open, the waves entering the canal in storms tear off the sheet-piling.

Harbor entrance at Lake Superior.—The entrance to the canal is formed by two approximately parallel piers of substantial crib-work which have resisted the storm waves and ice floes in a satisfactory manner since completed in 1873. The hardpan bottom of indurated clay upon which they rest has been of marked advantage in preserving their stability. These piers, 1,000 and 850 feet long, are of timber and stone of the usual pattern. They are 100 feet apart at the shore-line, widening irregularly to 240 feet at the lake entrance, where the depth at the date of our survey was 20 feet. Annual dredging is necessary here.

* Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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The ice during the winter is said to pile up in a solid mass, forming an artificial shore-line which tends to cause accumulations, and thus aggravates the usual creeping of sand round the ends of the piers.

The problem of constructing an entrance to the canal safe for large vessels during the great storms which prevail on Lake Superior in the spring and autumn is a difficult one. The tops of the present piers rise 6 feet above the surface of the lake when calm. The Board visited the place during a moderate gale from the westward on October 20. The rollers were coming in with their solid crests fully up to the top of the cribs. Where the defective trace presented surfaces normal to the direction of motion, spray was thrown many feet into the air and solid water poured over the wood-work in large volumes. The wave oscillation extended into the canal quite perceptibly for 300 or 400 feet. We were informed that in the great northeast and northwest gales, when the wind blows more directly in the line of the canal, wave motion is felt half a mile from the lake.

If a harbor of refuge is to be made at this place, it is a matter of vital importance to render the canal entrance safe in storms. A report upon the subject by Maj. H. M. Robert, Corps of Engineers, will be found in Senate Ex. Doc. No. 32, Forty-sixth Congress, second session.

VALUE OF THE IMPROVEMENTS.

The importance of this work to the general commerce of the Lakes, and its necessity for extending and developing the production of copper in the Lake Superior mines, have already been considered. It remains to determine what is a fair recompense to the present proprietors for the improvements and franchises which they proposed by letters to General Poe, dated November 22 and December 1, 1884 (Senate Ex. Doc. No. 15, Forty-eighth Congress, second session), to transfer to the Government free of all incumbrances for the sum of $350,000, and which proposition was renewed verbally to the Board by Mr. J. H. Chandler, the attorney of the companies, at a meeting of the Board on October 18, 1886.

There are three modes of approaching this subject: (1) What interest upon this sum of $350,000 is now and probably will be paid by the net revenues to which the company are entitled by law; (2) to what extent will the works and property proposed to be transferred to the Government reduce the cost of the improvements needed by commerce; (3) what has been the actual investment of private funds over and above the amount already contributed by the Government, viz, the value of the 398,205.42 acres of public lands donated to aid "in the constructing and completing a harbor and ship-canal?" Each of these questions will be considered in turn.

(1) The legal tolls of the two corporations are regulated differently. Those of the Lake Superior Ship-Canal Railway and Iron Company are established by the State Board of Control, under the provisions of an act of the State of Michigan approved April 25, 1873. Those of the Portage Lake and River Improvement Company are fixed by commissioners appointed by the board of supervisors of Houghton County. The rates of authorized tolls are shown by printed statements, of which copies are appended, marked G* and H*, respectively.

From Exhibit P, appended to House Mis. Doc. No. 50, Forty-eighth Congress, first session, it appears that the total expense for improve-

* Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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ments and repairs of the Lake Superior Ship-Canal from 1874 to 1883, inclusive, was $70,146.79. These expenditures are exclusive of salaries or other expenses incidental to maintenance of organization. The total receipts of tolls and all income from canal and other sources connected with its operation was $75,053.13, leaving, probably, no net profit.

Mr. James Pryor, superintendent of the canal, supplements this exhibit by the following figures extracted from his statement appended and marked I*:

Income from season of—	
1884, from tolls	$9.585.08
1885, from tolls	10,115.50
1886 (to September 30)	6,439.88
	26,140.46
Expense for repairs, dredging, and superintendence in—	
1884	8,368.20
1885	5,997.92
1886 (to September 30)	5,000.00±
	19,366.12

showing a total net income from the beginning of the season of 1884 to the end of September, 1886, of $6,774.34.

These figures indicate that, considering the large sums expended in its construction, the canal has thus far proved, financially, a failure. No office expenses other than those at Houghton are included in these figures, and a net profit of $1,000 per annum would be a large estimate, even with the increased traffic to be expected in the near future.

The exhibit of the Portage Lake and River Improvement Company is more favorable. From Mr. Pryor's statement, appended and marked K,* it appears that the total expenditure from 1872 to 1885, inclusive, including repairs, dredging, and superintendence, was $120,755.71, of which $75,118.72 was for dredging and $10,598.74 for pier-work and cribs. The annual expenses of this company may therefore be estimated at about $8,500.

The freight business of this company for 1884, 1885, and to October 12, 1886, and its gross income for 1884 and 1885 are exhibited by Mr. Pryor's statements appended and marked L* and M.* The latter, for 1884, is given as $33,968.01, and for 1885 $26,142.08. The falling off was caused by the permanent reduction in tolls which took effect in 1885. The net annual income over expenses from the investment represented by the Portage River improvement is, therefore, at current rates, about $17,500.

From the foregoing figures it appears that the two improvements which the companies propose to transfer to the United States for $350,000 now yield them an annual net income of about $18,500, and that lake commerce in the future may be expected to increase rather than diminish these figures. But to avoid loss at this price the funds received in payment must be reinvested so as to yield a little over 5 per cent. annual interest ($18,500 is 5 per cent. upon $370,000). The proposition of the companies seems, therefore, to be fair and reasonable.

(2) As to the money value of the existing works in reducing the outlay for such improvements as are now demanded by the needs of commerce at this locality, no definite estimate can be made until the details of such improvement are determined; but it is certain that the Gov-

*Omitted. Printed in House Ex. Doc. No. 105, Forty-ninth Congress, second session.

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ernment, from this point of view, also will receive a fair equivalent for the price asked by the companies. The works, as they now exist, could not be constructed for that price, and, consisting largely of needed excavation, they will not be sacrificed to any great extent.

(3) What sums have been actually expended upon the canal and harbor on Lake Superior can not now be determined with precision. The subject was investigated by General Poe in 1884, and reported upon by him in Senate Ex. Doc. No. 15, Forty-eighth Congress, second session. After all the new study which it has been possible to give to the subject, the Board agrees with General Poe in his conclusion that "the probability is great that the aid supplied from all sources and applied to the construction and repair of the canal and in operating it down to the beginning of 1884 amounted to fully $3,000,000." The whole of this sum was raised by the company from private sources, except what accrued from the donation of 398,205.42 acres of public lands actually received from the General Government under the grants of 400,000 acres. At the time the title was transferred this was wild land, worth in the market $1.25 per acre, making the money value of the grants amount to $497,756.77. It is reported that some of these lands have since proved to be mineral lands and very valuable, but what bearing this has upon the present question is not apparent. Indeed, the terms of Senate resolution of inquiry of April 22, 1884, which recites that the value of this land shall be estimated at $1.25 per acre, is regarded by the Board as fixing the proper valuation at the above amount.

The amount of work done by the Portage Lake and River Improvement Company to the end of 1883 is stated with considerable precision in a letter of Mr. S. W. Thurlow, secretary of the company, contained in Appendix C to General Poe's report. Since that date the superintendent, Mr. Pryor, states that 41,870 cubic yards have been dredged, making a total of 813,707 cubic yards to date; but the company has avoided furnishing accurate information as to the cost of the work. The price has varied from 90 cents for hardpan and bowlders and 30 cents for sand, paid in 1862–'63, to about 25 cents subsequently. Assuming 40 cents as a fair average, the company has expended upon dredging alone about $320,000, a very large portion of this being for maintenance and not construction. When the cost of the pier, 950 feet long, land purchases, etc., are taken into account, it would seem that the whole price now asked for both improvements can not very largely exceed the private funds actually invested in one of them by the Portage Lake and River Improvement Company.

In fine, the Board is of opinion that the price asked for the existing improvements is just and reasonable. The investment has greatly benefited commerce and the mining interests. The franchises now owned by the corporations have been legally and fairly acquired, but they bear heavily upon commerce and especially upon the population of Houghton County, and the companies seem willing to yield to the popular demand for a free water-way so soon as they are protected against actual loss themselves. The pressure for the purchase does not originate with the owners of the property, but with the mining population and the general commerce of the lakes.

RECOMMENDATIONS.

The Board, after careful consideration of the subject in all its bearings, and in the light of all the information it has been able to collect, submits the following recommendations:

(1) That the offer of the companies be accepted, to transfer all right and title to the canal, the work of improvement on Portage River, the

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harbor works upon Lake Superior and Keweenaw Bay, with all lands and franchises connected therewith, free from all incumbrances and involving no other payments for bonds or otherwise whatsoever, for the gross sum of $350,000.

(2) That the route be made a free water-way of the United States, subject to no tolls or assessments whatever, and be placed upon the same footing as to maintenance as the Louisville and Portland Canal.

(3) That under the authority conveyed by section 2 of the river and harbor act of August 5, 1886, the harbor lines indicated upon accompanying map No. 2 be approved by the honorable Secretary of War; that the Engineer officer in whose district this water way is situated be instructed to inspect from time to time and report any and all infringements thereon, and that the proper legal means be adopted for abating any such infringements in the future.

The existing bridge would be a very serious impediment to navigation if this route were improved to an extent to justify its use by the entire commerce of Lake Superior; and the same may be said of the existing deposits from the stamp-mills. Appropriate legislation is recommended.

(4) That a navigable depth of 16 feet at the lowest known lake level, with a minimum width of 70 feet on the bottom, be obtained by dredging throughout the entire extent of the water-way. This will involve the removal of 285,000 cubic yards of sand and hardpan in the canal, at a cost of $99,000, and 149,000 cubic yards, mostly of soft material, in Portage River, at a cost of $30,000. To this should be added about $75,000, roughly estimated, for putting the existing revetment in the canal in serviceable condition, calling for a total appropriation of, say, $225,000, including contingencies.

Should the future needs of commerce demand an increase in navigable depth to 20 feet at the lowest known lake level, it is probable that an increase in width of at least 50 feet will also be necessary, involving new revetments, for which an estimate of $200,000 would probably not be excessive; the excavation would amount to 989,000 cubic yards of hard and soft material in the canal, at a cost of $350,000, and 782,000 cubic yards in Portage River, mostly of soft material, which will cost $180,000.

(5) That the harbor entrance on Lake Superior (Map 4) be advanced into the lake to a depth of 30 feet by two piers of crib-work loaded with stone; that the new entrance thus made be 400 feet in width and situated in front of the present entrance; that the piers diverge inwardly upon angles of 45° with the axis of the canal to afford interior space to reduce the waves, and that their inner ends be connected with the shore by low piers rising only to the ordinary lake surface, with a view, while excluding sand, to facilitate the escape of waves entering the harbor in storms. Such an entrance would involve 3,940 feet of high piers, at a cost of $689,000, and 1,400 feet of low piers, at a cost of $70,000, calling, with contingencies, for an appropriation of, say, $850,000.

(6) That the pier at the Keweenaw entrance be extended to reach water 20 feet in depth by ordinary crib-work, about 2,400 feet long, which, with contingencies, will call for an appropriation of, say, $220,000.

RECAPITULATION.

For extinguishing private franchises	$350,000
For opening a through route having a minimum depth of 16 feet and a minimum bottom width of 70 feet	225,000
For providing a safe entrance from Lake Superior	850,000
For providing a safe entrance from Keweenaw Bay	220,000
	1,645,000

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When the increasing needs of commerce demand a depth of 20 feet an additional expenditure of $730,000 will be required.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
O. H. ERNST,
Major of Engineers.
CHAS. J. ALLEN,
Major of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

N.—REPORT ON SURVEYS MADE BY ORDER OF THE BOARD.

UNITED STATES ENGINEER OFFICE,
Saint Paul, Minn., December 8, 1886.

MAJOR: I have the honor to submit the following report on a survey and examination of Portage Lake and Lake Superior Ship Canal, a portion of Portage Lake at Houghton Mich., and of Portage River and entrance to Portage Lake, or the water-route from Keeweenaw Bay to Lake Superior through Portage Lake.

On September 21 received a telegram from you to report in Saint Paul to fit out party for the above survey. Mr. A. J. Stibalt and Mr. S. L. Rice were engaged as assistants, and Mr. F. L. Dever as recorder, and, with a surveying outfit of instruments, stationery, etc., the party left Saint Paul for Houghton, Mich., on September 29 and arrived there on the evening of the 30th.

The small steamer *Annie R. Hennes* was engaged to prosecute the work. The survey of the ship-canal was made first, as being most needed for meeting of the Board of Engineers at Houghton on October 16. The survey of this canal was made as follows, according to instructions received from you:

NATURE OF SURVEY.

Each bank of the canal was carefully chained and each 100 feet marked plainly. Soundings were taken across the canal at each 100 feet, and 20 feet apart. A heavy insulated copper wire about 180 feet long was marked at each 20 feet, and with this stretched across the canal at each 100 feet the soundings could be made very accurately. A cedar pole 17 feet long, carefully marked to tenths of a foot, was used for soundings. A gauge was set near the United States life-saving station, being about midway between Portage Lake and Lake Superior. This gauge was set the same day as one at Houghton, both gauges being set to read 1 foot on that day, or the zero of the gauge was, on an average, 1 foot below the surface of the water.

Careful cross-sections were taken at each 500 feet in length of canal, the levels extending back 300 feet from revetment on each side. For the low land and bog near Lily Pond the cross-sections were taken at each 1,000 feet, as there was but slight change of level at this end of the canal.

The Lake Superior entrance to the canal is protected by solid crib-work on piers 20 feet wide. With this crib-work the canal begins to widen on the west side at an angle of 37½° to the direction of the canal until it is carried out to 190 feet from center line of the canal. From thence the crib-work is parallel with direction of the canal for 375 feet. This west line of crib-work is then changed in direction 87° towards the center till its inner face is 130 feet from center line. Thence it extends parallel with the direction of the canal to the outer end 390 feet. At the outer end there is a large crib 61 feet in width and 30 feet in direction of the canal, to give strength and protection to the outer end. On the east side the crib-work begins 20 feet farther out towards Lake Superior, and runs parallel with canal for 60 feet, then widens at an angle of 20° to the line of the canal until it reaches a point where inner side of crib is 115 feet from center line of canal. It then extends directly out in the lake on line of canal with width of 20 feet for 500 feet, then with a width of 32 feet for 130 feet more, or to within about 40 feet of being as far out as the crib-work on the west side. The distance between the piers at the outer end is 2.0 feet.

The revetment of the canal banks commencing at the Lake Superior or upper end is as follows: From the crib-work inward for 500 feet, two rows of piles are driven 7 feet apart and 7 feet between the rows. The front row of piles is capped by timbers 1 foot square, there being three cap timbers bolted to the piling and to each other with 1-inch square iron bolts from 1½ to 2 feet long. The piling are sawed off about 6 or 8

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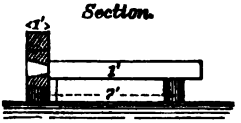
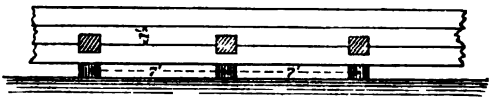
inches above surface of water as observed during this survey. This front part of revetment is strengthened by tie timbers dovetailed into the front timbers between the lower and second pieces and bolted to the pile directly back of front row 7 feet, the head of the back pile being sawed off to receive this tie on a horizontal from its connection with front timbers. Sheet-piling 4 inches thick are driven so as to face on the back part of the cap timbers to which the sheet-piling is spiked (see sketch).

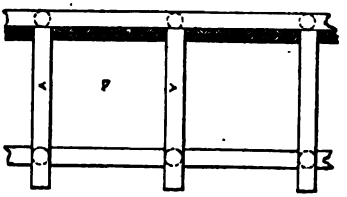
Section.



Front View.



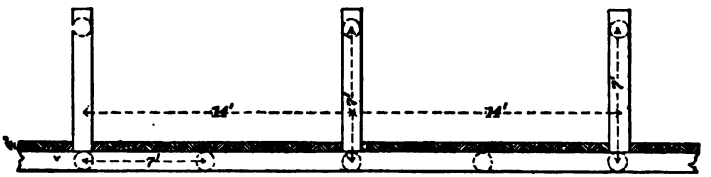
Plan.



The revetment is the same on both east and west sides of the canal, the width between the revetments being about 100 feet.

From this point, 500 feet from the piers, the revetment changes, only having two cap timbers, and the tie timbers only occur every 14 feet, as shown in sketch.

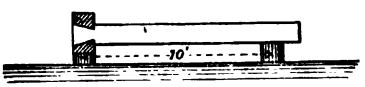
Plan.



This extends on both sides of the canal down to within 400 feet of turning point 1, (T. P. 1), or about 3,770 feet. From this point to T. P. 2 or for 850 feet, there is a cap timber on the back row of piling. From T. P. 2 to T. P. 3, 360 feet, the back row of piling is only 6 feet back of front row, the form of construction remaining the same.

From T. P. 3 down until we cross Lily Pond, back cap timber is wanting on both the east and west sides, and the capping on the west side consists of only one timber 1 foot square. This extends for 1,200 feet. From this point through Lily Pond and for about 1,900 feet to a point 520 feet below T. P. 5, the construction is as follows: There is no sheet-piling on either side. The east side is constructed as shown by sketch.

Section.



Front View.

The west side from opposite point 1,200 feet below T. P. 3 consists of piles driven 1 foot apart with one cap timber 1 foot square connected with back piling every 10 feet as in sketch below:

Side View.

This form continues for about 1,900 feet, or to opposite 520 feet below T. P. 5. From this point both east and west revetments change and there is sheet-piling again. The piles are driven 7 feet apart and with rear line of piling 7 feet back.

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There are two cap timbers and tie timbers every 7 feet, all the same as at the other end of the canal. This extends to a point 400 feet below or south of T. P. 6, or for about 2,603 feet. From opposite this point on the west side, the revetment is again changed to piling driven 1 foot apart and one cap timber, which extends down to crib in Portage Lake, or for 630 feet. There is no piling back of this line, and consequently no tie timbers, and the condition of the revetment is very bad, the cap timbers and piling being missing in some places. On the east side the revetment from this point, 400 feet below T. P. 6, continues the same for 250 feet as above the point, except an extra row of piles 14 feet back of face of revetment, and then for 280 feet more, or to the crib, there are three cap timbers.

The crib on the east side at the end of the revetment contains the beacon light. The crib on the west side at the end of the revetment is about 20 feet square, but contains no signal.

The width between revetments at the lower end, or in Portage Lake, is about 210 feet, which narrows up to 125 feet at T. P. 6 and to 100 feet 200 feet farther up the canal.

BORINGS.

For borings to test the banks and bottom of the canal, an apparatus consisting of two pieces of 1-inch gas-pipe was made, the lower length being 17 feet and the upper 10 feet, coupled together with an ordinary coupling. The lower end was drawn to a point, and a 2-inch auger welded to the pipe. Clasp arms of iron, made to set at any point, were used to handle the apparatus.

At the Portage Lake and Lake Superior Ship Canal borings were made as follows:

At point in canal near outer end of revetment, or at beginning of pier-work, and about 18 feet from west edge of the canal, in 14 feet depth of water. Sand and stones (most likely a deposit since the canal was built) were met with till a depth of 16 feet, then hardpan to a depth of 20.5 feet, beyond which it was impossible to bore with the apparatus used. Also at point opposite Red Store, 30 feet from east revetment, in 13 feet depth of water. To a depth of 19 feet below water-surface only sand was met with. From this point to 21 feet below surface a mixture of hardpan and sand was met with.

Another boring was made about 50 feet south of the United States life-saving station on east side of canal. Soft material was met with till down 17.9 feet below water-surface; then hardpan and gravel were encountered, and we could not reach a greater depth with apparatus. Through Lily Pond and down to Portage Lake the bottom, so far as examined, was quite soft to a depth of 21 feet.

BED OF HARDPAN.

As to the material in the banks of the canal, we have the following statement from Mr. James Pryor, superintendent of the Portage Lake and Lake Superior Ship Canal Railway and Iron Company:

"There is a continuous bed of hardpan, beginning a little north of the United States Lake Survey station, and extending out into the lake as far as we dredged to give 20 feet of water, its surface or upper portion conforming to the general topography of the land through which the canal is cut, rising higher through the deep portion of the cutting near Lake Superior, and sloping south according to the surface of the canal bank. At the Red Store it is found about 3 or 4 feet below the surface of water, and gradually increasing in height till midway between Store and lake shore it reaches to the surface of water, and from thence to the Government light-house it reaches above the water, till at the lake shore and under the light-house it is 5 or 6 feet above water-line, so that practically all the dredging required to deepen or widen the canal at upper end would be hard digging. If the surface burden of sand was removed pretty well back from the proposed new line of enlargement, I think there would not be any trouble to secure the canal bank with good, substantial sheet-piling."

At the Lake Superior end of the canal it is about 1,600 feet from the general trend of the shore out to 25 feet depth of water, and at the Portage Lake end it is about 4,500 feet to the same depth. The dredging in Portage Lake would be mostly sand and loose material, while in Lake Superior there would undoubtedly be hardpan beneath a thin layer of drift sand.

MAPS.

The map of the canal portion of this survey is made on a scale of 1 inch = 100 feet and one giving approaches to canal at each end on a scale of 1 inch = 400 feet.

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STAMP-MILL DEPOSITS.

A survey of Portage Lake at Houghton and Hancock was made to determine encroachments made in the lake channel by the débris of the copper stamp-mills. This survey extends from about one-half mile above, or west of, the refuse or dump of the Atlantic mine stamp-mill, to about 3 miles below the old Isle Royale dump, which covers all territory occupied by the copper stamp-mills on Portage Lake. This encroachment in the most extreme case amounts to about 900 feet, reducing an original channel from about 1,300 feet to 400 feet, or to only 350 feet between the dock line opposite and the face of the dump. This survey was carefully made and checked by a system of triangulation from a carefully chained base on railroad track in Hancock. Careful cross-sections were made with level at each dump.

The map of this survey was made on a scale of 1 inch = 400 feet.

PORTAGE RIVER.

The survey of Portage River extends from 35 feet depth of water in Portage Lake to a depth of 33 feet in Keweenaw Bay, including the whole river-bed and cuts. This survey was also covered with a system of triangulation from a carefully chained base.

The original channel or bed of the river was sounded by diagonal lines from bank to bank as in ordinary surveys, while the cuts that were made by the Portage River Improvement Company to straighten the channel were examined as in Portage Lake and Lake Superior Ship Canal, the lines of sounding being 100 feet apart, and soundings 20 feet on line of cross-section.

Borings were also made along bed of river and in cuts at several different places, only sand and soft bottom being met with all along the river and out into Keweenaw Bay, except at Cut No. 4, Church's Landing, in 15.4 feet depth of water, where sand, gravel, and stones were found at a depth of 19.1 feet below water-surface, where rock was encountered that could not be penetrated with this boring apparatus. Several points were tried in the immediate vicinity with same result. As stated by Mr. Pryor, this rock is a shaly sandstone, and extends in quite regular strata from this cut to the head of Portage River, or to within a few hundred feet of Portage Lake, but only occurring in that part of the river bed and banks on line from this cut (No. 4) to the head of the river, and is not met with in the bend of the river between these points.

Cross-sections were made at both outer and inner end of Cut No. 1, or the entry from Keweenaw Bay, at Pacific Dock, and at Cuts Nos. 2, 3, and 4. There is no revetment of banks in the cuts along Portage River, the banks apparently holding in place quite satisfactorily.

WATER-GAUGES.

A gauge was also set in Portage River to correspond with the Houghton gauge as nearly as possible, being spiked to a pile in Mr. John Hallè's dock (Union Dock).

These three gauges, viz, at Portage River, at Houghton, and at Portage Lake and Lake Superior Ship Canal, were all connected with good permanent bench-marks. The survey of Portage River is mapped on a scale of 1 inch = 400 feet.

The gauge-readings during these surveys were not subject to extreme changes during such weather as soundings could be taken, generally ranging from 0.9 feet to 1.1 feet during heavy wind storms, or just after there would be more extreme high or low readings, according to the direction of the wind, the greatest range being from 0.7 feet to 1.3 feet; but such extreme high or low readings would only last for a few minutes.

To determine average stage of water during this survey, in reference to lowest water, or the stage for other known periods, careful levels were taken between the surface of the lake and three well-established bench marks at Marquette, Mich., the work being done on November 9, during general calm and fair weather, the gauge at Houghton being carefully read at 9 a. m., on leaving that place for Marquette. From this data the surface of the lake on that day was found to be 601.32 feet above sea-level, and from examinations of gauge-readings at Sault Ste. Marie, during this survey, the above result was found to give a close agreement. The gauge-readings both at Duluth and Sault Ste. Marie, for several years back, were used to arrive at a low-water determination, which gave a result that corresponded very closely to an actual determination in Portage River from data furnished by Mr. John Hallè at Union Dock, he having observed a low-water point in front of a small dock used by his family for obtaining water from the river, the rocky bottom in front of the dock just showing at surface of water during the low period. Mr. Hallè has lived at this point for twenty years. From all low-water data it was found to be about 1 foot lower than the average stage for this survey, or 600.4 feet above sea-level.

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ESTIMATE FOR 16-FOOT DEPTH.

The examination of the ship-canal as to depth shows a somewhat irregular bottom, and although a great part of the length of the canal would admit the passage of boats drawing 15 feet of water, yet there were several places where not more than a draught of 13 feet could be carried, which reduced the capacity of the canal to that draught. To increase the depth to correspond to the 16 feet as adopted for the chain of lakes would require the removal of the following amount of material:

70,000 cubic yards hardpan, at 80 cents	$56,000
90,000 cubic yards soft material (in canal), at 20 cents	18,000
125,000 cubic yards soft material (in Portage Lake), at 20 cents	25,000
Total	99,000

This amount would deepen the canal for a width of 70 feet in the center, leaving 15 feet on either side as at present, so as not to disturb the revetment. In Lily Pond for about 300 feet the deepening was allowed for over 100 feet in width. There was also allowed an increase of 1 foot in depth in center for keels of vessels. Portage Lake would be deepened for 300 feet in width to 17 feet depth. The above depth of 16 feet refers to low water or to a plane 600.4 feet above sea-level.

To carry this draught of water through to Keweenaw Bay would require dredging in Portage River, as follows:

Soft material, 146,500 cubic yards, at 20 cents	$29,300
Stones, gravel, etc. (in Cut No. 4), 2,600 cubic yards, at 25 cents	650
Total	29,950

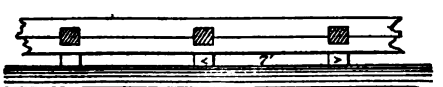
This amount might have to be increased somewhat at the cuts unless the banks at these points were to be revetted. The total length of actual cuts in Portage River is about 3,300 feet. For about one-fourth the length of the river the present channel would fill the requirements, and at several points there is extra width of good depth of water that would allow steamers and fleets to pass each other safely in severe weather.

In the ship-canal the revetment is in poor condition throughout its entire length, and to put the work in good shape would require a renewal. Some of the piles and timbers might be used in a renewal, but the cost of removing the old material would probably be as great or greater than the value of the material that could be used. Hence an estimate is submitted for new revetment throughout.

For 100 feet of revetment.

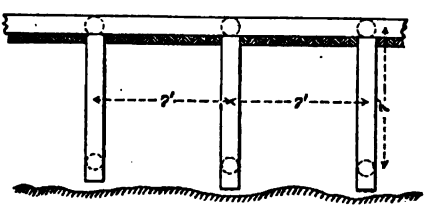
30 piles, 1 foot diameter, 20 feet long	linear feet..	600
3 longitudinal timbers (1 by 1 foot), 300 linear feet	feet, B. M..	3,600
15 tie timbers (1 by 1 foot), 135 linear feet	do....	1,620
200 planks (1 foot by 4 inches), 16 feet long	do....	12,800
15 iron bolts (1 inch by 1 inch) 3 feet each	pounds..	150
15 iron bolts (1 inch by 1 inch), 2½ feet each	do..	125
400 spikes ($\frac{7}{8}$ inch by 8 inches)	do..	200

Front View.



Section.

Plan.



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Estimated cost for 100 feet in place.

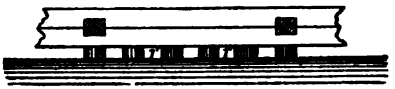
Piling, 600 linear feet, at 20 cents	$120.00
Square timber, 5,220 feet, B. M., at $25	130.50
Plank, 12,800 feet, B. M., at $30	384.00
Iron bolts, 275 pounds, at 5 cents	13.75
Spikes, 200 pounds, at 5 cents	10.00
Total cost for 100 feet	658.25
For 20,000 feet	131,650.00

The revetment for Lily Pond would not need sheet-piling and could be made as in present construction on west side, only using two cap timbers, instead of one as at present.

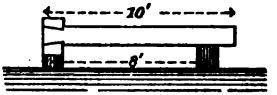
For 100 feet of revetment.

60 piles (1 foot in diameter), 25 feet long each	linear feet..	1,500
2 timbers (1 foot by 1 foot), 100 feet long each, 200 linear feet	feet, B. M..	2,400
10 timbers (1 foot by 1 foot), 10 feet long each, 100 linear feet	do....	1,200
50 iron bolts (1 inch by 1 inch), 3 feet long each, 150 linear feet	pounds..	500
10 iron bolts (1 inch by 1 inch), 2 feet long each, 20 linear feet	do....	67

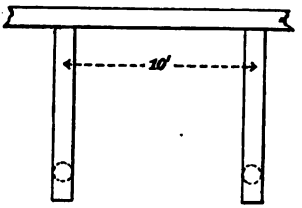
Front View.



Section.



Plan.



Estimated cost for 100 feet in place.

Piling, 1,500 linear feet, at 20 cents	$350.00
Square timber, 3,600 feet, B. M., at $25	90.00
Iron bolts, 567 pounds, at 5 cents	28.35
Total per 100 feet	468.35
For 4,000 feet	18,734.00
For revetment of whole canal	150,384.00

To give a condensed statement of estimated cost for clear channel-way of 16 feet depth from Lake Superior to Keweenaw Bay we have the following:

Total cost of dredging in ship canal	$99,000
Total cost of dredging in Portage River	29,950
Total cost of revetment in ship canal	150,384
Grand total	279,334

In regard to right of way for the ship canal there is ample width for enlargement if such should be contemplated, as the grant or purchase specifies a uniform width on each side the center line of the canal ample for enlargement to a width of 300 feet at least.

In the Portage River the grants of land would be ample if the present line of improvement were to be followed, but if any straightening of the channel were contemplated it would probably require more purchases. Such land as would be required, though, would be only bog and marsh and of but little value.

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Accompanying this report are sketches of portions of Portage River where land purchases were made by the Portage River Improvement Company, giving their location outlined with red lines.

No land survey marks near these locations could be found during this survey, even though inquiries were made of the old residents, and that Mr. Emerson, the county surveyor, spent one afternoon with us. As we had connected carefully with stakes set for the light-house reserve for the range lights, application was made to the office of light engineers at Detroit, Mich., and from such data as were furnished the section lines and locations were put on the map of this survey according to the true meridian.

Very respectfully, your obedient servant,

G. A. MARR,
Assistant Engineer.

Maj. C. J. ALLEN,
Corps of Engineers, U. S. A.

G G 5.

IMPROVEMENT OF MARQUETTE HARBOR, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1866, III, 8; IV, 81). $385,129.58
Appropriated 329,230.00

The project for the improvement of this harbor was adopted in 1866. It consisted in the formation of a crib breakwater, extending from a point north of the city of Marquette in a direction due south for a distance of 2,000 feet, thus affording a protection to the water-front of the city.

Work was begun in 1867, and the breakwater was completed to its present length of 2,010 feet in 1875, at a cost of about $291,000, or $94,000 less than the estimated cost. Since its completion appropriations amounting to $37,500 have been made, of which about $27,000 have been expended on repairs.

This harbor is of the greatest importance, its commerce being very extensive and constantly increasing, and is also valuable as a harbor of refuge.

The original project has been completed, but more protection is needed and should be afforded, either by considerable extension of the present breakwater or the construction of a detached work, as may be deemed necessary, the latter method being considered preferable.

A proposition was made to and approved by the Engineer Department to retain the funds on hand, with the exception of such amounts as may be needed for current repairs, until by further appropriations a sufficient sum becomes available to prosecute new work advantageously.

During the fiscal year extensive repairs were made to the breakwater.

Cribs Nos. 36 to 39, inclusive, 200 linear feet, were supplied with additional riprap.

Three hundred and fifteen linear feet of the decayed superstructure, Cribs 1 to 8, inclusive, was cut down to the water's edge and rebuilt six courses in height. The upper timber on the east side of the entire length of the breakwater was also removed and replaced with new timber. The above repairs commenced July 10 and were completed October 16, 1886.

On November 16 and 17, 1886, a storm of unusual severity occurred, causing extensive damage to the breakwater, demolishing the pier-head light and about 600 linear feet of the elevated walk. The planking of cribs Nos. 15 to 40 inclusive, 1,300 linear feet, was more or less injured; 600 linear feet of the harbor face of the superstructure damaged, 300

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feet of the same being carried away down to the water's edge, and over 200 cords of stone filling washed out of the cribs. The structure was so weakened by the effect of this storm, that a breach seemed inevitable, if repairs were delayed until the spring of 1887. Work, therefore, was commenced December 1, and pushed as rapidly as materials could be obtained and the weather would permit. But slight interruptions occurred, and the repairs were completed January 15, 1887.

Upon the opening of navigation in the spring of 1887 it was found that the stone washed out of the cribs in November and deposited on the west side of the breakwater had decreased the depth of water so that abreast of cribs Nos. 28 to 31 inclusive, in places, but from 8 to 10 feet existed. A portion of these stones were removed in May, 1887, increasing the depth to from 12 to 12½ feet, and signs placed on the west face of the cribs cautioning vessels drawing more than 12 feet not to make fast to that portion of the breakwater.

All of the operations during the fiscal year were performed by hired labor and open purchase.

Water-level observations were made and recorded daily during the year.

Since the completion of the present project there has been a tendency on the part of riparian owners to seriously encroach upon the portion of the harbor protected by the breakwater, greatly reducing its available area and especially impairing its efficiency as a harbor of refuge.

The office records show that for several years past complaints of these encroachments have been made by the collector of the port of Marquette and by various vessel-masters, particularly of the practice of a lumber company of mooring rafts of logs to the breakwater, making fast to the elevated walk leading to the pier-head light, thereby interfering with vessels seeking the harbor. This same lumber company built a wharf in the winter of 1883–'84 547 feet long parallel to the breakwater, with an L at right angles extending to within 60 feet of the cribs, inclosing an area of about 6 acres adjacent to the shore end of the breakwater. During the present season this company has built another dock 412 by 100 feet 65 feet beyond the former dock, thus further encroaching upon the available harbor space.

There has also been a tendency to make very large extensions to the ore-docks, one company announcing its intention to extend its dock 700 feet beyond its present terminus, but the completion of the railroad from Marquette to Negaunee seems to have diverted the ore shipments to Escanaba, and the proposed dock extension has not been made.

The attention of the mayor of the city of Marquette was called to this subject by Lieut. Col. J. W. Barlow, Corps of Engineers, in February, 1886, and finally the common council of the city of Marquette, on September 4, 1886, adopted an ordinance fixing and defining the harbor limits, these being evidently so chosen as to take in the proposed ore-dock extension and the wharves of the lumber company. A copy of this ordinance, with an accompanying chart showing the limits, was referred to this office by the Chief of Engineers, and the following report was made:

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., October 18, 1886.

SIR: In accordance with instructions contained in the Department indorsement of October 9, 1886, I have the honor to submit the following report upon the harbor limits as established by the common council of Marquette, Mich.:

In my opinion the lines as established by the common council are very injudiciously laid down; they seriously encroach upon the available harbor space, and will practically ruin this fine port as a harbor of refuge.

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It may be asserted that acts of Congress making appropriations for the improvement of rivers and harbors are intended to benefit the general public, and that the intended ore-dock extension will be of great benefit to the commercial interest, but the river and harbor act is intended to benefit the water and not the land public, and these dock extensions will not give extra facilities for loading so much as for storing, for instead of having the ore in the cars on the sidings ashore, the ore can be stored in the pockets of the dock, to the great relief of the rolling-stock and of the side-tracks, but in order to do this almost the entire harbor is sacrificed.

Opposite page 330 of Part II, Report of the Chief of Engineers for 1876, will be found a map of Marquette Harbor, with a line marked "limit of dock extension." This line was recommended by Assistant Engineer W. H. Hearding, in a report to Col. D. C. Houston dated January 31, 1875, in obedience to instructions from that officer.

This limit seems to have met the approval of Colonel Houston and his successors in charge of Marquette Harbor. In my judgment these lines are well chosen, and I recommend them as far preferable to those recently established by the common council.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Since the date of this report nothing further on the subject has been received.

It is most urgently recommended that any further appropriation for the improvement of this harbor shall contain a proviso that no money whatever shall be expended until the question of harbor limits has been settled to the satisfaction of the War Department.

Money statement.

July 1, 1886, amount available	$11,063.52
Received from sale of fuel to officer	36.00
Amount appropriated by act approved August 5, 1886	10,000.00
	21,099.52
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	10,775.70
July 1, 1887, amount available	10,323.82
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	100,000.00

Statement of materials and labor used at Marquette Harbor, Michigan, in repairing 895 linear feet of breakwater by hired labor and open purchase during the fiscal year ending June 30, 1887.

Articles.	Quantity.	Price.	Total cost.
Timber and plank.....feet, B. M..	239,314	$10.00 to $15 00	$3,279.73
Stone.....cords..	339.26	4.50 7.00	1,779.78
Drift bolts.....pounds..	13,530	.02½	338.25
Iron.....do ..	5,197	.02½	116.98
Spikes.....do ..	4,000	.02 88/100	118.00
Tools, etc			171.47
Labor and superintendence			3,326.90
Total			9,131.06

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COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Marquette, Mich.; collection district, Superior, Mich.; nearest light-house, Marquette, Mich.

(1) Amount expended to June 30, 1887	$318,942.18
Amount required to complete improvement	0.00
Annual cost of preserving and maintaining	4,200.00

The original project has been completed, but more protection is needed and should be afforded either by considerable extension of the present breakwater or the construction of a detached work, as may be deemed necessary.

(2) Amount of commerce and navigation when work of improvement began in 1867.

Statistics of commerce and navigation were not attainable for the year 1867, but during the year 1869 the number of clearances from this port of steamers and sailing vessels was 1,238.

(3) Amount of commerce and navigation at present time.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Arrivals and departures of vessels.

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	175	199,350	164	195,187
Sail-craft	601	330,796	590	328,140
Total	776	530,146	754	523,327

PRINCIPAL ARTICLES OF EXPORT AND IMPORT.

EXPORT.

	Approximate value.
Iron ore	$4,268,485
Pig-iron	161,000
Lumber	226,400
Machinery	250,000
Total	4,905,885

IMPORT.

Coal	$532,872
Flour	15,055
Machinery	150,000
Miscellaneous	314,445
Oil and provisions	89,229
Brick, slate, and iron rails	44,980
Total	1,146,581

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

The great bulk of the commerce of Marquette is carried by water, but little going by rail, which would seem to demonstrate conclusively the advantages to this port of water transportation over rail.

There is no direct route of transportation by rail to this point, the Chicago and Northwestern road reaching but to Negaunee, a place 12 miles distant, whence freight must be hauled over another road. There is little or no competition between rail and water.

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The improvement has unquestionably lessened the cost of transportation, and in giving increased facilities for navigation has tended to reduce the rates of marine insurance.

(5) Prospective advantages to commerce, as well as benefits to the community, by the completion of the proposed improvement.

The original project is completed, but further harbor accommodation is needed to meet the increased demands of commerce and to add to the present value of the port as a harbor of refuge.

G G 6.

HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1881, page 2053)..... $450,000
Appropriated 131,250

The necessity for a harbor of refuge on the American shore of Lake Superior, at some point between Whitefish Bay and Grand Island, a distance of 85 miles, was felt by navigators long before the commerce of the lake had assumed the importance it now possesses.

Grand Marais, from its locality, about midway between these points, and from its natural topographical features, seemed to be the most desirable place for the construction of a work of the character needed.

Surveys of the locality were made in 1871 by Maj. D. C. Houston and in 1881 by Maj. H. M. Robert. The present project of improvement was adopted on the report of a Board of Engineer Officers made in the latter year. It consists in the construction of an artificial entrance to the natural harbor by cutting a channel through the sand-spit which protects the harbor on the north, and in building two crib-piers, extending from the cut to the 22-foot contour in Lake Superior, the distance between the piers to be 500 feet.

The first appropriation for this work was made in 1880, $10,000 being granted. This sum was not sufficient to commence the work with to advantage, and remained unexpended until, by the appropriation of $20,000 in 1881 and $40,000 in 1882, enough money was available with which to begin operations. A contract was entered into in October of the latter year and work of pier construction begun.

Under the appropriation of August 5, 1886, of $26,250, a contract, dated October 25, 1886, was entered into with Mr. Castle Sutherland, of East Saginaw, Mich., for building and sinking in place nine cribs, each 50 by 24 by 14½ feet. During the present working season it is proposed to extend the west pier 450 feet under this contract. Operations commenced June 17, and at the close of the fiscal year the building of cribs was in progress but none had been completed.

By hired labor and open purchase minor repairs were made to the piers during the fiscal year, as follows: 200 linear feet of the west pier, cribs Nos. 16, 17, 18, and 19, and No. 15 of the east pier, were supplied with additional riprap, and the planking of both piers repaired.

Severe storms in the fall of 1886 carried out the end crib of the west pier. An effort was made to reset it, but owing to stormy weather and the lack of proper appliances was unsuccessful, so it was deemed advisable to secure the crib and to defer further action until work commenced on the pier extension and better facilities were at hand for resetting it. Arrangements are now being made to reset it as crib No. 16 of the east pier.

With the money asked for the fiscal year ending June 30, 1889, it is contemplated to continue pier construction.

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The percentages of work under the approved project accomplished and under contract are as follows:

Pier construction:	
Substructure	.623
Superstructure	.145
Dredging	.07
Length of east pier June 30, 1887 feet	750
Length of west pier June 30, 1887 do	950
Length of east dike June 30, 1887 do	100
Length of west dike June 30, 1887 do	100
Number of cubic yards dredged to June 30, 1887	32,104

Money statement.

July 1, 1886, amount available	$4,143.62
Amount appropriated by act approved August 5, 1886	26,250.00
	30,393.62
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,161.30
July 1, 1887, amount available	28,232.32
Amount (estimated) required for completion of existing project	318,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received and opened September 24, 1886, for extension of piers at harbor of refuge, Grand Marais, Mich.

No.	Name and address of bidders.	Pine timber (12" by 12" and 12" by 18", 14,300 linear feet), per linear foot.	H. block timber (12" by 12" and 12" by 18", 22,360 linear feet), per linear foot.	Pine plank (40,000 feet, B. M.), per M, B. M.	Stone (1,300 cords), per cord.	Wrought iron drift-bolts (30,400 pounds), per pound.	Wrought iron screw-bolts (9,500 pounds), per pound.	Wrought iron spikes (1,300 pounds), per pound.	Total.
1	Truman & Cooper, Manitowoc, Wis	$0.32	$0.27	$20.00	$11.00	$0.03	$0.04	$0.04	$27,053.00
2	Schwarz & Berner, Green Bay, Wis	.31½	.29	18.00	11.25	.04½	.05½	.05	28,288.50
*3	A. S. Bretherton, Jackson, Mich	.36	.36	15.00	10.00	.04	.05	.04	28,534.00
4	John H. Gillett, Marquette, Mich	.35	.35	20.00	12.00	.06	.06	.06	31,700.00
5	Wm. T. Casgrain, Milwaukee, Wis	.38	.38	25.00	10.00	.04½	.06	.05	29,929.00
†6	Castle Sutherland, East Saginaw, Mich	.30	.25	20.00	8.00	.05	.05	.05	23,140.00

*Informal. No guaranty accompanying bid.
†Informal. No guaranty accompanying bid. Informality waived, and bid accepted.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

(1) Amount expended to June 30, 1887	$103,017.68
Amount required to complete improvement	318,750.00
Annual cost of preserving and maintaining	8,700.00

(2) Amount of commerce and navigation when work of improvement began in 1880. This is intended for a harbor of refuge simply, and not for a commercial port, and there was no commerce in 1880.

(3) Amount of commerce and navigation at present time.

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Arrival and departure of vessels.

	Number.	Tonnage.
Steamers	52	4,000
Sailing vessels	13	1,000

Principal articles of Export:

	Approximate value.
Lumber and shingles	$20,000
Fish	3,000
Wood	500

Principal articles of import:

General merchandise	40,000
Hay and grain	10,000
Saw-mill supplies	3,000
Stone	500

Amount of revenue collected. None.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance and also upon the rates of competing routes of transportation.

There are no competing routes of transportation, and the only effect the work will have on rates of freight and insurance will be that generally due to decreased dangers to vessels navigating Lake Superior.

(5) Prospective advantages to commerce, as well as benefits to the community, by the completion of the proposed improvement.

Although Grand Island Harbor, some 40 miles to the eastward of Marquette, is an excellent harbor of refuge, it is somewhat off the track of vessels going east or west, and is difficult of entrance for strangers. It has not been used as much as was expected when lighted and buoyed by the Light-House establishment. Grand Marais will therefore be practically the only harbor of refuge between Marquette and Whitefish Bay, a distance of 125 miles.

G G 7.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1880, page 1931)	$6,000
Appropriated	6,000

The project of improvement for this harbor consisted in dredging between the piers built by the Chicago Lumbering Company, increasing the depth of the channel to 12 feet for a width of 150 feet.

An appropriation of $5,000 was made for this purpose in 1880, and of $1,000 in 1881.

The only work done under these appropriations was the removal of 11,780 cubic yards of material in 1880, under a contract with the Chicago Lumbering Company.

In October, 1880, a survey of the harbor showed that the direction of the piers lay across the natural channel. At this time the company, which had built the piers, and had also secured the contract for dredging, found it necessary to renew about 330 feet of the west pier, which had been washed away.

The superintendent of the company was notified by the officer in charge, Maj. H. M. Robert, that the pier lines would have to be rectified to accord with the natural channel. The company declined to comply with this demand, and their contract, which had been extended

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from December, 1880, to June 1, 1881, was suspended. There have been no operations at this harbor since, and no money is asked for its improvement.

Money statement.

July 1, 1886, amount available	$3,501.79
July 1, 1887, amount available	3,501.79

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Manistique, Mich.; collection district, Superior, Mich.; nearest light-house, Poverty Island.

(1) Amount expended to June 30, 1887, $2,498.21.

The original estimated cost of the improvement of this harbor was $6,000; which amount was appropriated and a balance of $3,501.79 is now available.

(2) Amount of commerce and navigation when work of improvement began in 1880.

Arrivals and departures of vessels during the calendar year 1880.

	Number.	Tonnage.
Arrivals	102	25,250
Departures	101	25,034

Value of exports during the same period	$207,000
Value of imports during the same period	113,000

(3) Amount of commerce and navigation at the present time.

Application for these statistics for the calendar year 1886, was made to parties interested in the improvement and from whom it has been customary to receive this information, but they have not yet complied with the request.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance and also upon the rates of competing routes of transportation.

There are no competing routes of transportation, and as the intended work of improvement was never completed, it has probably had no effect on rates of freight and insurance.

(5) Prospective advantages to commerce, as well as benefits to the community, by the completion of the proposed improvement.

The interests being entirely local and the work stopped, no prospective advantages to commerce are likely to accrue.

G G 8.

IMPROVEMENT OF CEDAR RIVER HARBOR, MICHIGAN.

Original estimate (see Report of Chief of Engineers, 1882, page 2121)	$138,000
Appropriated	30,000

The project for improving this harbor contemplated the construction of two piers, 200 feet apart, extending from the river-mouth to the 16-foot curve in Green Bay, and the dredging of a channel 14 feet deep at low water; about 800 feet of these piers, beginning at the shore-line, to be built of piles, and the remainder of cribs.

The first appropriation ($15,000) for carrying out this project was made in 1882, and was applied to the construction of a pile-pier 14 feet wide, extending from the east bank of the river into the bay, a distance of 553 feet.

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Under a contract with Schwarz & Berner, of Green Bay, Wis., dated November 4, 1884, the east pier was extended 201 feet, and the west pier begun and built to a length of 300 feet, making a total of 501 feet of pier built under this contract. Operations closed November 19, 1885.

There were no operations during the past fiscal year.

Soundings made in October, 1885, showed a channel about 50 feet in width 13 feet deep, and 100 feet in width 11 feet deep.

The commerce of Cedar River is entirely local and incidental to a single saw-mill. A harbor of refuge does not seem to be needed at this point, and if it were, the conditions are not favorable for its construction.

Length of east pier June 30, 1887	feet..	754
Length of west pier June 30, 1887	do....	300
Dredged to June 30, 1887	cubic yards..	10,583

Money statement.

July 1, 1886, amount available	$2,670.02
July 1, 1887, amount available	2,670.02
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	108,000.00

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Cedar River, Michigan; collection district, Superior, Mich.; nearest light-house, Chamber's Island, Michigan.

(1) Amount expended to June 30, 1887	$27,329.98
Amount required to complete improvement	108,000.00
Annual cost of preserving and maintaining	5,100.00

This amount, equal to 4.7 per cent. of the total cost of the original contemplated improvement, is based on the supposition of periodical dredging and renewal of the crib superstructure.

(2) Amount of commerce and navigation when work of improvement began in 1882.

During the calendar year 1882 the arrivals and departures of vessels aggregated 710, with a tonnage of 131,000.

PRINCIPAL ARTICLES OF EXPORT AND IMPORT.

EXPORTS.

Laths	number..	7,000,000
Pickets	do....	1,000,000
Posts	do....	320,000
Lumber	feet, B. M..	48,230,000

IMPORTS.

Brick	number..	100,000
Iron and steel	pounds..	2,000,000
General merchandise	tons..	1,400
Grain	bushels..	42,000

(3) Amount of commerce and navigation at present time.

During the calendar year 1886 the arrivals and departures of vessels aggregated 370, with a tonnage of 104,000 tons.

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PRINCIPAL ARTICLES OF EXPORT AND IMPORT.

EXPORTS.

Lumber	feet, B. M..	28,500,000
Pickets	number..	700,000
Posts	do....	150,000
Laths	do....	5,000,000
Shingles	do....	8,000,000

IMPORTS.

Brick	number..	75,000
Iron and steel	pounds..	50,000
General merchandise	tons..	1,130
Grain	bushels..	700

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

There are no competing routes of transportation to this harbor, and the effect on freight and insurance rates has been that naturally due to increased facilities of entrance and departure.

(5) Prospective advantages to commerce, as well as benefits to the community by the completion of the proposed improvement.

The interests at this harbor are of a local character, the business, which consists in the manufacture and shipment of lumber, being confined at present to a single sawmill. It is not considered that the benefits to be derived warrant a continuation of the improvement of this harbor at present.

GG 9.

IMPROVEMENT OF MENOMONEE HARBOR, MICHIGAN AND WISCONSIN.

Original estimate (see Report of Chief of Engineers, 1874, I, page 139)	$212,000
Appropriated	203,000

Previous to the improvement of this harbor the depth of water at the mouth of the Menomonee River, one of the largest emptying into Lake Michigan, was about 4 feet, and the river was navigable for boats of that draught for about 2 miles from its mouth.

The first appropriation for its improvement was made in 1871, but the plan for the improvement was not decided upon until after this appropriation was made. No original estimate was made, the project providing for the construction of two parallel piers 400 feet apart and extending to the 14-foot contour in Green Bay, with a dredged channel 14 feet deep between the piers.

In 1874 an estimate was made aggregating $212,000, and providing for extending the piers to the 15-foot contour.

The north pier is now completed, in accordance with existing project, being 1,854 feet long, and terminating in 16 feet of water. The south pier is 2,710 feet long and terminates in 11 feet of water, projecting into Green Bay about 100 feet beyond the north pier. To reach the same depth of water as the north pier would require an extension of 350 feet, which would make this pier project 450 feet beyond the north pier, which, as the pier head-light is on the north pier, would be very objectionable.

The bar, removed by dredging during the past fiscal year, projected about 350 feet beyond the south pier and extended three-fourths of the distance across the channel, with a depth of from 11 to 14 feet of water over it.

The navigation of this harbor presents some peculiar and exceptional features, viz: Vessels entering for cargoes come light, and no heavily-

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laden craft seek it for shelter; the departing lumber-laden vessels, with a draught of 13 or 14 feet, wait for smooth water, and consequently the usual allowance of 4 feet play in depth is not necessary at this harbor.

The extension of the south pier is not considered necessary, for if the bar should re-form it could be removed by dredging at small expense.

During the past fiscal year, by hired labor and the use of the United States dredges, 37,895 cubic yards of material were removed from the harbor and outer bar, making a channel 270 feet wide and 14 feet deep.

The Menomonee River Lumber Company still continue their unauthorized and improper use of the south pier by piling their lumber thereon, while they moor heavy barges and scows to the north pier. It is earnestly recommended that no further appropriations of money be made for this harbor unless this practice is discontinued.

Money statement.

July 1, 1886, amount available	$3,130.17
Amount appropriated by act approved August 5, 1886	3,000.00
	6,130.17
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,029.66
July 1, 1887, amount available	3,100.51
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	9,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Menomonee, Wis. Collection district, Superior, Mich. Nearest light-house, Menomonee, Wis.

(1) Amount expended to June 30, 1887	$199,899.49
Amount required to complete improvement	9,000.00
Annual cost of preserving and maintaining	7,800.00

(2) Amount of commerce and navigation when work of improvement began in 1872.

STATISTICS OF COMMERCE FOR FISCAL YEAR ENDING JUNE 30, 1872.

Arrivals and departures of vessels.

	No.	Tonnage.	Value of cargoes.
Vessels arrived	983	358,863	$1,113,940.23
Vessels departed	1,027	378,435	1,223,269.37

(3) Amount of commerce and navigation at present time:

STATISTICS OF COMMERCE FOR CALENDAR YEAR 1886.

Arrivals and departures of vessels.

	Arrivals.		Departures.	
	No.	Tonnage.	No.	Tonnage.
Steam	168	23,986	167	23,630
Sail	420	125,871	419	124,842
Total	588	149,857	586	148,472

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The principal articles of import are provisions and general merchandise, and have an approximate value of $60,000,000. The principal export is lumber, with an approximate value of $75,000,000.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation:

The railroads reaching Menomonee are the Chicago and Northwestern and the Milwaukee and Northern. The Chicago and Northwestern is the only direct road, however, and the only competitor with boats for freight. A comparison of rates charged by this road in 1873 and in 1886 shows a reduction of 4, 9, 12, and 3 cents per 100 pounds on the first, second, third, and fourth classes of merchandise, respectively. What proportion is due directly to the harbor improvement it is impossible to say. It may be observed, however, in this connection, that at Oconto Harbor, for instance, where the road encounters no opposition from boats, the rates of 1886 are the same as charged in 1881. The effect of the improvement upon insurance rates and rates of competing routes of transportation has been to reduce them.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement:

At the time of commencing the improvement of this harbor in 1872 the population of the town of Menomonee did not exceed 1,000, and the commerce carried on by water did not exceed in amount $3,000,000. In 1885 the population had increased to about 6,000, and the commerce to many million dollars over that of 1872.

The general commerce of the country as well as the local commerce is benefited by this improvement, and the statistics would assuredly seem to justify the work already done, and to warrant the completion of the proposed improvement; but the unauthorized and improper use made of the south pier by the Menomonee River Lumber Company in storing lumber upon it, and the injurious practice of mooring heavy barges and scows to the north pier, lead to the opinion that further work should be suspended at this harbor unless these injurious practices are discontinued.

G G 10.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers 1883, page 1646)	$150,000
Appropriated	48,000

The history of this work of improvement is somewhat peculiar.

A survey of the mouth of the Oconto River was ordered by the act of July 11, 1870, and was made in the same year under the direction of Maj. D. C. Houston, Corps of Engineers, who reported that—

> General commerce and navigation will not be benefited by a harbor at this point. The amount required for the active and permanent completion is $500,000. (See Report of Chief of Engineers for 1871.)

The act of March 3, 1879, directed a re-examination or survey, which was also made under Major Houston's direction, and in October, 1879, that officer reported a reduced estimate amounting to $382,027.18. (See Report of Chief of Engineers for 1880.) Both of these estimates were based on securing a 12-foot channel.

In January, 1881, the Secretary of War was informed that the citizens of Oconto had undertaken the work of improvement on a much more economical plan than that recommended by the Government engineer, and a request was made for a further examination with the hope that a small appropriation might be made in *aid* of the work. Major Houston made an examination, and while not indorsing the method of construction adopted by the citizens, reported that an appropriation of $5,000 or $10,000 "would be of great assistance" to the people in carrying on the work of improvement.

The character of the citizens' plan and estimate may be judged from the fact that they proposed to build 1,800 feet of pier for $1,500, or 83⅓ cents per linear foot.

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The act of March 3, 1881, appropriated $10,000 for improving Oconto Harbor, it is believed on the strength of the above-quoted remark of Major Houston.

Maj. H. M. Robert, Corps of Engineers, having succeeded to the charge of the work, submitted a project in 1881 to obtain an 8-foot channel, at an estimated cost of $125,000.

This was modified in 1883, the revised estimate involving a total cost of $150,000, which is the project at present being carried out.

This project is for a channel 8 feet deep and 100 feet wide from the Section street bridge in Oconto to the shore-line in Green Bay, a distance of about 2 miles, and the extension of this channel to the 10-foot contour in Green Bay by means of two parallel piers 150 feet apart, these piers being built in continuation of the slab-piers built by the city of Oconto.

The first appropriation for this harbor was made in 1881, and work was begun in the ensuing year.

Under the appropriation of $8,000 by act approved August 5, 1886, the United States dredges, during the past fiscal year, removed 65,661 cubic yards of material, mainly from between the piers, resulting in a channel 100 feet wide and 10 feet deep at the entrance, diminishing to 8 feet deep at the shore-line.

Minor repairs were also made to the south pier, and 250 linear feet were riprapped.

A breach of about 50 feet in length was closed, and small quantities of slabs and edgings were used at various places in the pier where undue settlement of the filling had occurred.

The re-enforcement of 1,200 linear feet of the south pier by a row of piles 3 feet apart from center to center, provided with wales, and tie rode at intervals of 9 feet, was commenced in June and is now in progress. It will be completed early in July.

In other improvements in this district it has been customary for the United States to improve only the part of the harbor outside the shore-line, leaving that inside for the local authorities to work upon. There seems no reason why this harbor should be made an exception, especially as the commerce is small, and, from its dependence on the lumber interests, probably temporary.

The channel is often used for booming and mooring logs and lumber scows, and the piers, built in the cheapest practicable manner, are constantly receiving injuries from such use, the piles being frequently broken and the slab filling washing out. That part of the piers built by the citizens was so poorly constructed that unless rebuilt or extensively repaired it will soon afford no protection and render the outside work unavailable.

A breach about 60 feet in length near the shore end of the south pier recently occurred, and on June 21 I notified the mayor of its existence and the necessity of its prompt repair, it being understood that the city would rebuild the 1,000 feet of pier built in 1880. (See Report of Chief of Engineers for 1883, page 1645.)

The south pier is built to the full length contemplated by the approved project.

To complete the north pier to the 10-foot contour, as originally designed, would require an extension of 875 feet, at a cost of about $10,000. As the south pier is the weather pier and as the north pier is protected by it and by Peshtigo Point, it would seem to be unnecessary to extend the north pier further.

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It is recommended that, if Congress should continue to make appropriations for this improvement, the expenditure of the money be made contingent on the city of Oconto keeping in repair the part built by private enterprise.

Length of north pier, June 30, 1887	feet..	1,603
Length of south pier, June 30, 1887	do...	2,151
Number of cubic yards dredged to June 30, 1887		207,641

Money statement.

July 1, 1886, amount available	$102.51
Amount appropriated by act approved August 5, 1886	8,000.00
	8,102.51
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,998.37
July 1, 1887, amount available	4,104.14
Amount (estimated) required for completion of existing project	102,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing piles, received and opened at Milwaukee, Wis., March 7, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidders.	200 piles, 26 feet long, 5,200 linear feet.	200 piles, 24 feet long, 4,800 linear feet.	Cost.
		Cents.	*Cents.*	
1	Leathem & Smith, Sturgeon Bay, Wis.* ,.....per linear foot..	9⅝	9⅝	$937.50
2	J. N. Elmore & Co., Green Bay, Wis.....do....	10	10	1,000.00

*Accepted.

Abstract of proposals for furnishing iron screw-bolts and tie-rods, received and opened at Milwaukee, Wis., May 7, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidders.	Iron screw-bolts and tie-rods, (16,179 pounds), per pound.	Cost.
		Cents.	
1	S. D. Kimbark, Chicago, Ill *.....	3.1	$501.55
2	Vulcan Iron Works, Chicago, Ill.....	3.93	635.83
3	Milwaukee Bridge and Iron Works, Milwaukee, Wis.....	3.75	606.71
4	Cook, Case & Sorenson, Green Bay, Wis	3.85	622.89
5	Shadbolt, Boyd & Co., Milwaukee, Wis.....	3.25	525.82
6	Robert Rowe, Milwaukee, Wis	4.9	792.77
7	Joseph Obenberger, Milwaukee, Wis	3.5	566.26

*Accepted.

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Abstract of proposals for furnishing stone, received and opened at Milwaukee, Wis., May 7, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidders.	Stone (94 cords) per cord.	Cost.
1	E. S. Minor, Sturgeon Bay, Wis	$5.00	$470.00
2	Gregoire Denis, Bay Settlement, Wis*	4.24	398.56
3	Leathem & Smith, Sturgeon Bay, Wis	4.69	440.86

*Accepted.

Abstract of proposals for furnishing white pine timber, received and opened at Milwaukee, Wis., May 7, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Name and address of bidder.	White pine timber (21,420 feet B. M.), per M., B. M.	Cost.
1	Leathem & Smith, Sturgeon Bay, Wis*	$15.43	$330.51

*Accepted.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Oconto, Wis. Collection district, Milwaukee, Wis. Nearest lighthouse, Sherwood Point, Wis.

(1) Amount expended to June 30, 1887 ..... $43,895.86
Amount required to complete improvement 102,000.00
Annual cost of preserving and maintaining 5,800.00

(2) Amount of commerce and navigation when work of improvement began in 1881:

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1881.

Arrivals and departures of vessels.

	Number.	Tonnage.
Arrivals	86	30,000
Departures	90	32,000
Total	176	62,000

Principal articles of import:	Approximate value.
Saw-logs	$200,000
Cedar ties and posts	45,000
Brick, lime, and stone	33,000
Pork and beef	24,000
Hay and grain	8,000
General merchandise	400,000
	710,000
Principal articles of export:	
Lumber, lath, and shingles	625,000
Cedar posts and ties	150,000
Telegraph and hoop poles	12,000
Hard-wood staves	5,000
Wood	20,000
Farm products	28,000
	870,000

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(3) Amount of commerce and navigation at present time.

COMMERCIAL STATISTICS FOR THE CALENDER YEAR 1886.

Arrivals and departures of vessels.

	Number.	Tonnage.
Arrivals	172	86,000
Departures	169	83,000
Total	341	169,000

Principal articles of import:	Approximate value.
Brick, lime, and stone	$65,000
Pine saw-logs	360,000
Cedar posts and ties	80,000
General merchandise	200,000
Grain and hay	18,000
Coal and wood	11,000
	734,000

Principal articles of export:	
Lumber, lath, and shingles	720,000
Cedar posts and ties	140,000
Slab wood	18,000
Farm products	68,000
Telegraph and hoop poles	18,000
Boxes, crates, sash, doors, etc	125,000
	1,089,000

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

The competing routes of transportation to this point are the Chicago and Northwestern Railroad, and the Milwaukee, Lake Shore and Western. A table of freight rates, furnished by the Chicago and Northwestern, does not show any difference between the rates charged in 1881 and now. This port is not touched by lake steamers, but only by miscellaneous sailing craft, so that there is no competition between rail and water transportation, and no apparent effect upon rates of freight.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

The navigation interests at Oconto are at present dependent upon the business of three lumber companies located there, and the benefits to be derived are essentially local.

GG 11.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers, 1883, page 1652)..... $50,000
Appropriated 15,000

The first appropriation for the improvement of this harbor was made by act of Congress passed August 2, 1882, the river and harbor act containing an item of $10,000 for the purpose.

The project consisted in continuing a slab-pier, which had been built by private enterprise, until it should reach the 10-foot contour in Green Bay, and in dredging a channel south of this pier to a depth of 10 feet and width of 100 feet, connecting the deep water in the river with the deep water in the bay.

The condition of the harbor has not materially changed since the last annual report.

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There were no operations during the past fiscal year.

There has been no increase of commerce, and consequently no necessity for asking for an appropriation for continuing this improvement.

Money statement.

July 1, 1886, amount available	$4,446.92
July 1, 1887, amount available	4,446.92
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	35,000.00

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Pensaukee, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Tail Point, Wis. Amount of revenue collected, none.

(1) Amount expended to June 30, 1887	$10,552.08
Amount required to complete improvement	35,000.00
Annual cost of preserving and maintaining	2,900.00

(2) Amount of commerce and navigation when work of improvement began in 1881.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1881.

Arrivals and departures of vessels.

	Number.	Tonnage.
Steamers	30	8,420
Sailing-vessels	40	15,680
Total	70	19,100

EXPORTS BY WATER.

Fish	barrels..	600
Lumber	feet, B. M..	10,000,000
Pickets	number..	15,000
Posts	do....	125,000
Sawdust, pressed	tons..	750
Shingles	number..	8,000,000
Ties, railroad	do....	20,000
Wood	cords..	4,000

IMPORTS BY WATER.

Grain	bushels..	11,000
Provisions	barrels..	658
Saw-logs	feet, B. M..	5,000,000
Sundries	tons..	125
Lime and salt	barrels..	700

(3) Amount of commerce and navigation at present time.

Practically none.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

There are no competing routes of transportation. Pensaukee is reached by the Chicago and Northwestern Railroad only, and there is no apparent effect upon the rates of freight produced by the improvement of this harbor.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

None.

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G G 12.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Estimated cost of present project (see Report of Chief of Engineers, 1881, page 2069)	$135,000
Appropriated	105,000

The total appropriations for the improvement of this harbor amount to $277,550, most of which has been applied to dredging.

The maintenance of a good channel here is important to the navigation of the Fox River.

The present project consists in dredging a channel 200 feet wide and 14 feet deep at low water, extending from the mouth of Fox River to deep water in Green Bay, a distance of 2 miles, including a revetted cut through Grassy Island. At present this channel is 175 feet wide, and from 13 to 14 feet deep. During the past fiscal year, the only operations have consisted in placing 248¾ cords of stone filling in the east revetment at Grassy Island. Preliminary arrangements have been made to rebuild the superstructure upon the west revetment during the present working season by hired labor and open purchase, the work to commence early in July.

The work as designed for the improvement of this harbor is now nearly completed, and when finished will furnish the needed harbor facilities for the present requirements of commerce. The unappropriated balance of the original estimate, $30,000, is deemed sufficient for the entire completion of the work under the present plan.

With the money asked for for the fiscal year ending June 30, 1889, it is contemplated to dredge the channel to the dimensions called for by the present project.

Length of east revetment June 30, 1887	feet..	705
Length of west revetment June 30, 1887	do....	620
Total number of cubic yards dredged to June 30, 1887		764,786

Money statement.

July 1, 1886, amount available	$42.10
Received from sale of fuel to officer	36.00
Amount appropriated by act approved August 5, 1886	7,000.00
	7,078.10
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,656.96
July 1, 1887, amount available	5,421.14
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing stone received and opened at Milwaukee, Wis., June 18, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidders.	Stone, 200 cords, per cord.	Cost.
1	Leathem & Smith, Sturgeon Bay, Wis	$3.94	$788.00
2	Gregoire Denis, Bay Settlement, Wis*	3.74	748.00
3	Eagle Bluff Stone Company, Ephraim, Wis	6.00	1,200.00
4	Christian Schwarz, Fort Howard, Wis	5.15	1,030.00

*Accepted.

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Abstract of proposals for furnishing iron screw-bolts, tie-rods, and drift-bolts, received and opened at Milwaukee, Wis., June 18, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidders.	Iron screw-bolts and tie-rods (9,462 pounds), per pound.	Iron drift-bolts (2,625 pounds), per pound.	Cost.
		Cents.	*Cents.*	
1	Chicago Forge and Bolt Company, Chicago, Ill	3.25	2.75	$379.70
2	Milwaukee Bridge and Iron Works, Milwaukee, Wis	3.7	2.93	427.53
3	Shadbolt, Boyd & Co., Milwaukee, Wis*	2.74	2.74	331.18

*Accepted.

Abstract of proposals for furnishing white pine timber received and opened at Milwaukee, Wis., June 18, 1887, by Capt. Charles E. L. B. Davis, Corps of Engineers.

No.	Names and addresses of bidder.	White pine timber 92,600 feet, B. M., per M, B. M.	Cost.
1	Christian Schwarz, Fort Howard, Wis	$16.99	$1,573.27
2	Leathem & Smith, Sturgeon Bay, Wis.*	15.43	1,428.82

* Accepted.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Green Bay, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Grassy Island, Wisconsin.

(1) Amount expended to June 30, 1887 ..... $272,164.86
Amount required to complete improvement 30,000.00
Annual cost of preserving and maintaining 4,400.00

(2) Amount of commerce and navigation when work of improvement began in 1887:

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

Arrivals and departures of vessels.

	Number.	Tonnage.
Vessels arrived	677	139,608
Vessels departed	673	140,250

Principal articles of import:		
Fruit, tobacco, etc	packages..	3,921
Coal	tons..	700
Pig-iron	do....	400
Nails	kegs..	4,064
General merchandise	tons..	7,500
Principal articles of export:		
Grain	bushels..	734,228
Flour	barrels..	114,500
Railroad ties	number..	100,000
Shingles	do....	200,000,000
Lumber	feet, B. M..	40,640,000
Laths	number..	5,000,000
Brick	do....	1,305,000

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(3) Amount of commerce and navigation at present time.

STATISTICS OF COMMERCE FOR CALENDAR YEAR 1886.

Arrivals and departures of vessels.

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	457	100,033	469	102,425
Sail	196	30,188	204	31,074
Total	653	130,221	673	133,499

PRINCIPAL ARTICLES OF EXPORT AND IMPORT.

EXPORT.

	Approximate value.
Grain	$150,805
Flour	954,020
Lumber	93,276
Brick	4,222
General merchandise	50,000
Total	1,252,323

IMPORT.

Coal	322,975
Iron	20,000
Lumber	230,000
General merchandise	30,000
Total	602,975

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

A comparison of the freight rates charged by the Chicago and Northwestern Railroad in 1869 with those charged in 1886 shows a reduction of 12, 14, 16, and 16 cents per 100 pounds on first, second, third, and fourth classes of merchandise, respectively; but what part of this was effected by the harbor improvement it is impossible to state, although without question a very good percentage may be claimed.

The effect upon the rates of competing routes of transportation has been a reduction.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

The improvement here consists in securing a channel 200 feet wide, 14 feet deep at low water, and 2 miles long in place of the natural channel in Green Bay, including a revetted cut through Grassy Island.

This improvement materially shortens the route formerly traversed by vessels entering the harbor and renders the harbor, which is deep and spacious, accessible to all vessels from Green Bay, thus conferring great benefits upon the industry of the country and commerce of the lakes, as well as upon the community, and it is believed that the benefits to be derived will fully justify the completion of the proposed improvement.

GG 13.

HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY CANAL, WISCONSIN.

Estimated cost (see Report Chief of Engineers, 1874, I, page 141)	$180,000
Appropriated	165,000

The project of constructing a harbor of refuge inclosing the Lake Michigan entrance to the Sturgeon Bay Canal was adopted in 1871, and the pier-work was completed in the fall of 1884.

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The harbor is inclosed between two piers, each 1,200 feet long, beginning at equal distances, respectively, north and south from the lake ntrance to the Sturgeon Bay and Lake Michigan Ship-Canal, 850 feet apart at the shore-line, converging to a distance of 235 feet from each other, with detached piers extending 150 feet farther, the latter being so placed that the entrance is widened to 335 feet. The outer end of each detached pier is connected with the outer end of the adjacent main structure by 165 feet of fender-piling.

The project embraces the formation of a dredged channel of indefinite width, 16 feet deep, extending from the harbor entrance to the canal entrance.

As stated in previous reports the advantages expected to accrue to vessels navigating Lake Michigan, when the construction of a harbor of refuge at this place was projected, have not been entirely realized. In tempestuous weather the harbor is too limited and does not afford sufficient security to vessels seeking its shelter, often necessitating their passage through the canal to avail themselves of the superior advantages afforded by the natural harbor of Sturgeon Bay.

Tolls are exacted by the canal company from vessels using the canal either as an avenue of safety or for purposes of trade. As the construction by the United States of a harbor of refuge at the lake entrance of the canal is a direct benefit to the canal itself, it would seem no more than just that vessels seeking safety in the harbor and compelled to pass through the canal to secure such safety should be exempt from paying toll to the canal company. It is therefore recommended that such legislation be accomplished as shall render the canal free to vessels that may be compelled to use it through stress of weather.

During the past fiscal year, by hired labor and the purchase of material in open market, dredging with United States dredges continued until July 16, 1886, removing during that month 11,245 cubic yards of material, making a total during the working season of 1886 of 42,185 cubic yards removed from the harbor. No more dredging is at present required, although periodical dredging will probably be necessary until the canal is revetted its whole length.

Early in November, 1886, about 350 linear feet of the sheet-piling of the south pier was injured by a storm. To re-inforce it until it could be repaired, and to secure the remainder from probable injury, 101½ cords of stone were applied as riprap to 480 feet of the south pier and 200 feet of the north pier.

In May and June of the present year the piers were thoroughly repaired, and 20 feet of the north pier, injured by a wrecked vessel, was also placed in good order, by hired labor and open purchase.

Soundings taken June 2, 1887, show a least depth of water at the entrance of 15.7 feet, and 14 feet or over thence to the canal.

As the pier construction is completed, and no dredging required at present, it is probable that the available balance is sufficient for repairs and maintenance, therefore no appropriation is asked for for the ensuing year.

Under the requirements of the river and harbor act of August 5, 1886, a Board of Engineers was constituted to examine, in all their relations to commerce, the Sturgeon Bay and Lake Michigan Ship-Canal, with a view to making the same a free passage-way and harbor of refuge, to consider their value, and all other matters connected with their usefulness to navigation, and to give information as to the expediency of the work and the desirability of their acquisition and improvement.

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(For the report of the Board of Engineers see Ex. Doc. No. 106, H. R., Forty-ninth Congress, second session.)

Length of north pier, June 30, 1887	feet..	1,344
Length of south pier, June 30, 1887	do...	1,344
Length of guide-piling, June 30, 1887	do...	330
Length of pile-pier, sheet-piled, June 30, 1887	do...	1,392
Total number of cubic yards dredged to June 30, 1887		132,344

Money statement.

July 1, 1886, amount available	$2,205.58
Received from sale of fuel to officer	16.50
Amount appropriated by act approved August 5, 1886	5,000.00
	7,222.08
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,194.37
July 1, 1887, amount available	4,027.71

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, harbor of refuge at entrance of Sturgeon Bay Canal, Wis. Collection district, Milwaukee, Wis. Nearest light-house, entrance to harbor.

(1) Amount expended to June 30, 1887 ..... $160,938.79
Annual cost of preserving and maintaining 6,000.00

(2) Amount of commerce and navigation when work of improvement began in 1873. None.

(3) Amount of commerce and navigation at present time.

Commercial statistics for this harbor for the calendar year 1886 have not yet been received, and the figures of 1885 are used, as they are believed to be nearly those of 1886.

Number of vessels and their tonnage which passed through and sought refuge at the Sturgeon Bay and Lake Michigan Ship Canal during the calendar year 1885.

	Number.	Tonnage.
From Lake Michigan to Green Bay	2,515	442,701
From Green Bay to Lake Michigan	1,006	225,810
In canal for refuge	189	25,637
Total	3,710	694,148

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

In giving increased facilities for refuge to vessels, lessening the dangers of navigation, the effect of this improvement has been to reduce rates of freight and insurance. There are no competing routes of transportation.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

The project of providing a protected entrance to the Sturgeon Bay and Lake Michigan Ship-Canal is completed, and the harbor is available for purposes of refuge.

After entering the harbor vessels are obliged to lie within the ship-canal and to pay toll to the canal company for so doing, and not until such tolls are abolished can vessels receive the full and free benefit which the harbor was intended to confer.

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REPORT UPON THE EXPEDIENCY AND DESIRABILITY OF THE ACQUISITION BY THE GOVERNMENT OF THE STURGEON BAY AND LAKE MICHIGAN SHIP-CANAL.

WAR DEPARTMENT,
Washington City, January 24, 1887.

The Acting Secretary of War has the honor to transmit to the House of Representatives, to comply with the requirements of the river and harbor act of August 5, 1886, a letter of the 14th instant from the Chief of Engineers, together with a copy of the report, and its accompanying maps and papers, from the special Board of Engineers appointed to examine in all their relations to commerce the Sturgeon Bay and Lake Michigan Ship-Canal, connecting the waters of Green Bay with Lake Michigan, with a view to making the same a free passage-way and harbor of refuge; to consider their value and all other matters connected with their usefulness to navigation, and to give information as to the expediency of the work and the desirability of their acquisition and improvement.

The report exhibits in detail the origin of the canal, the history of its construction, its cost, and its relation to commerce, together with the conclusions of the Board as to the expediency of the work and the desirability of its acquisition and improvement by the United States.

The views of the Board are concurred in by the Chief of Engineers and by this Department.

S. V. BENÉT,
Brig. Gen., Chief of Ordnance,
and Acting Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 14, 1887.

SIR: I have the honor to submit herewith a copy of the report, with accompanying papers and maps, received at this office from the special Board of Engineer Officers constituted by your orders to comply with the requirements of the following provisions of the river and harbor act of August 5, 1886:

The Secretary of War is authorized and directed to appoint a Board of three Engineers from the United States Army, whose duty it shall be to examine, in all their relations to commerce, the Sturgeon Bay and Lake Michigan Ship-Canal, connecting the waters of Green Bay with Lake Michigan, in the State of Wisconsin, with a view to making the same a free passage-way and harbor of refuge, to consider their value, and all other matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the U. S. Army thereon.

As the result of a most careful, thorough, and impartial investigation by the Board of all matters relating to the subject under consideration, this report exhibits, with much detail, the origin of the canal; the history of its construction and its cost, and also its relation to commerce, and finally concludes as follows:

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(1) That if the barrier between Green Bay and Lake Michigan were now in its natural condition, the construction of a canal between them, on or near the line of the existing canal, would be a proper work to be done by the United States in the interests of commerce and navigation, but that the United States should not be made to become responsible for an insufficient canal encumbered with a heavy lien, results due to an inefficient agency not contemplated by the original act of Congress or recognized by any subsequent act.

(2) That the grant of land to the State of Wisconsin in 1866 was sufficient to have built the canal, and, should the United States assume control, no payment will be due equitably or legally for its construction and maintenance.

(3) That the existing depth of 13 feet in the canal is not adequate to the demands of the largest class of vessels on the Great Lakes, and therefore the canal, as it now exists, has only restricted importance.

(4) That the canal is not a harbor of refuge in any proper sense, and at best is only an approach to a sheltered bay which is capable of conversion into a harbor of refuge.

(5) That Sturgeon Bay is the true harbor of refuge, and to make it available as such, an ample basin should be excavated, the canal deepened, and works constructed in Lake Michigan exterior to the existing works of protection at the canal entrance.

(6) That the conversion of Sturgeon Bay into a harbor of refuge accessible through the Sturgeon Bay Canal to all vessels which navigate the Great Lakes would add great security to their shipping, and may be regarded as a public necessity.

(7) Whether the Government assumes control of the canal or not, the tolls collected on the vessels using it should not exceed the actual cost of operating and maintaining the said canal.

In submitting this report I beg leave to express my concurrence in the views of the Board.

Of the maps accompanying this report only one (Exhibit Z) is herewith. Duplicate copies of the others remain on the files of this office for record and for inspection.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

LETTER OF LIEUTENANT-COLONEL WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, PRESIDING OFFICER OF THE BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., December 3, 1886.

GENERAL: While, as the senior member, I send forward the unanimous detailed report of the Board on the subject of the Sturgeon Bay and Lake Michigan Canal, it seems not out of place to add a condensed statement of some of the circumstances of the case, with some suggestions. The two large bodies of water called Lake Michigan and Green Bay are separated by a strip of land about 75 miles in length and with an average width of 10 or 12 miles. Navigation between these bodies of water was originally maintained at the upper end of the bay.

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About mid-length of the bay there was a deep indentation in the western side of this separating land, known as Sturgeon Bay. Its eastern end was distant from the western shore of Lake Michigan about 1½ miles.

The advantages that would result from making another communication at this place between the lake and the bay were soon perceived. These were claimed to be: A considerable shortening of distance for many vessels, with a proportionate gain in time; the avoidance of the dangers of the natural route, with a consequent saving of life and property; an increase in the value of Sturgeon Bay as a place of refuge, by making it easily accessible from Lake Michigan as it already was from Green Bay.

In 1864 there was a corporation formed under the laws of the State of Wisconsin called "The Sturgeon Bay and Lake Michigan Ship-Canal and Harbor Company." Among its members were some of the leading capitalists of Chicago, Milwaukee, and northeastern Wisconsin.

Lumbering was one of the most important things engaging the attention of the population of that section of country, and it is found, not unexpectedly or unreasonably, that the promoters of the canal scheme and the managers of the canal during its making and operation have been engaged in or connected with this special business of lumbering and the industries developed by it and supported by it.

In April, 1866, Congress granted 200,000 acres of land to the *State of Wisconsin* to aid in the construction of a "breakwater and harbor and ship-canal at the head of Sturgeon Bay to connect the waters of Green Bay with Lake Michigan."

The State did nothing with the land, but turned it over to this pre-existing company, which, after the lapse of several years of intermittent work, made the canal. It is now held by the company, and tolls are charged upon it.

A proposition was introduced in the Senate at its last session for the United States to take possession of the canal on the payment of $150,000. This proposition did not become a law, but Congress directed the organization of a Board of Engineers to consider and report upon the canal.

The conclusion of the Board is that if the barrier between Green Bay and the lake were now in its natural condition, the construction of a canal between them, on or near the line of the existing canal, would be a proper work to be done by the United States in the interests of commerce and navigation; and if the United States now take it in charge, the Government should not become responsible for any existing lien upon it, and navigation upon it should be free.

The original law of Congress did not refer to the canal company in any way whatever. Section 5 imposed upon the State of Wisconsin the duty of causing "to be kept an accurate account of the sales and net proceeds of the land hereby granted, and of all expenditures in the construction, repairs, and operating of said canal, and of the earnings thereof, and of returning a statement of the same annually to the Secretary of the Interior."

This was one of the important conditions of the grant, which has not been regarded.

Another condition of the grant was that the canal should be completed within three years from April, 1866. This time was afterwards extended to April 10, 1874, but the canal was not one-fourth done at the last date.

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It may here be remarked that while section 5 of the law of 1866 contemplates the payment under certain circumstances of "legal interest on advances for the construction, repairs, and operating of said canal," it is understood that "legal interest" in Wisconsin is 7 per cent., and that compound interest is illegal. In this connection it should also be stated that the original amount advanced has been almost, if not altogether, refunded in the shape of tolls, and there is now in the treasury of the company from the same source some $10,000.

A fair construction of section 6 of the law of 1866 would seem to have required the canal to be 100 feet wide at bottom, whereas it was made 100 feet wide at the water surface, or about 50 feet wide at bottom. This difference of dimensions greatly diminished the cost of the canal as well as its commercial usefulness.

The terms of the law of Wisconsin of 1868, especially section 4, would indicate it had the expectation that the proceeds of the land grant would suffice ($\frac{1}{4}$ by $\frac{1}{4}$) to cover the cost of making the canal. And it may here be specially noted that when the first fourth of the canal had been accepted as done, the company received more than the law had probably intended to give them. In addition to the grant of land, Congress appropriated $180,000 for work contemplated in the original act of 1866 in which the grant was made, and executed a survey at a cost of several thousand dollars, the expense of which would otherwise have fallen upon the construction company.

It is claimed that the value of the grant was much lessened by the fire of 1871, but a fair offset to this is found in the notable increase in the price of lumber due to the demand for it after the great fire in Chicago.

Several questions suggest themselves for consideration.

Was it the intent of section 2 of the act of April 10, 1866, as to "the disposal" of "said lands" to have the State simply an intermediary between the United States and a corporation engaged in an operation apparently speculative, at least in part, when this corporation did nothing until it was vivified by a grant of United States lands?

Notwithstanding the decision of United States court in a case quite similar, which has been followed by the Interior Department, is it not doubtful whether any sale of land *by the company* was justifiable, as the canal was not completed in the legal limit of time, and the conditional requirement of reversion of the lands was so explicitly provided for by a *special law*?

The legislature of the State has signally failed in executing one of the conditions of the grant as specified by section 5 of the act of April 10, 1866. It seems doubtful whether the State had the right to substitute a subagent for itself without the prior consent of the United States.

In addition to the alleged and admitted general advantages of the canal, its construction had also the effect, whether expected or intended or not, of placing in the hands of a corporation at the expense of the United States a valuable property, profitable to that corporation in facilitating and cheapening the transportation of the lumber used in their business, and a source of revenue from tolls collected from others.

Considering the law of Congress of 1866, and the law of Wisconsin of 1868, it is doubtful whether the collection of tolls *by the canal company* has been justifiable.

If the construction of the canal was a public work alone, for which a grant was made by the United States to the State at its solicitation, is not the State responsible for and to its own inefficient agent?

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If the work was mainly private in its objects, should not the company which expected to profit by it be responsible for its own failure?

Is the United States properly responsible in any aspect of the case?

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Lieut. Col. of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF BOARD OF ENGINEERS.

NEW YORK CITY, *December* 3, 1886.

GENERAL: The Board of Engineers, constituted by Special Orders No. 112, Headquarters Corps of Engineers, United States Army, August 13, 1886, "to consider and report upon certain questions under act of Congress approved August 5, 1886, in connection with the Sturgeon Bay and Lake Michigan Ship Canal, connecting the waters of Green Bay with Lake Michigan," and reconvened by Special Orders No. 137, Headquarters Corps of Engineers, U. S. Army, Washington, D. C., September 20, 1886, and by Special Orders No. 164, Headquarters Corps of Engineers, U. S. Army, Washington, D. C., November 1, 1886, has the honor to transmit herewith its report.

The copy of the extract from the act of Congress approved August 5, 1886, submitted for the guidance of the Board, reads:

The Secretary of War is authorized and directed to appoint a Board of three Engineers from the United States Army, whose duty it shall be to examine, in all their relations to commerce, the Sturgeon Bay and Lake Michigan Ship Canal, connecting the waters of Green Bay with Lake Michigan, in the State of Wisconsin, with a view to making the same a free passage-way and harbor of refuge, to consider their value, and all other matters connected with their usefulness to navigation, and which shall give information as to the expediency of the work and the desirability of their acquisition and improvement. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon,

and was accompanied by the following instructions from the Chief of Engineers, dated Washington, D. C., August 14, 1886:

It is desired that the Board avail itself of all attainable information upon the subject upon which it is required to report, and to this end it will visit the locality, hold public meetings, giving due notice thereof through the newspapers or otherwise, as may appear best; invite discussion, orally or in writing; and, in short, use every effort to inform itself in regard to the origin of the work, the means provided for its construction, and its cost; to the present and prospective value of the work under consideration, to the interests of the commerce and navigation likely to be promoted by its acquisition and improvement by the Government, with a view of making the report full, complete, and exhaustive, and to this end every avenue of information should be pursued to its source.

The Board met at Milwaukee, Wis., September 10, 1886, and entered at once upon its duties by reading the order for its assembly, the act of Congress, and the special instructions prepared by the Department for its guidance, and the previous reports of officers upon the subject before it, and by examining the existing charts and plans of the canal and the estimates for the cost of construction. On the following day the Board visited Sturgeon Bay by crossing Green Bay from Menomonee, and made an inspection of the canal and works of Government improvements at the Lake Michigan terminus, returning September 12 to Milwaukee.

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In order that all attainable facts might be placed before the Board, it was found necessary to call upon the authorities of the State for copies of all papers showing the proceedings of the State under the law or Congress making a donation of public lands to aid in constructing the canal; and upon the canal company, the agents of the State, for an official statement of its financial status; and also to collect data bearing upon the commerce of the canal and its relations to the navigation of the great system of lakes.

The engineer officer in local charge, Capt. C. E. L. B. Davis, Corps of Engineers, was also requested to make a survey of the canal to determine its present condition, which he promptly undertook and completed.

After arranging for the collection of this information and for the publication of an advertisement calling for a public meeting to be held in Milwaukee October 21, 1886, at which a free interchange of opinion might take place among mariners and others in regard to making the canal a "free passage-way and a harbor of refuge," the Board adjourned, to be reconvened at Milwaukee October 20, 1886.

The Board re-assembled in Milwaukee on the day last mentioned, considered the papers and charts received and prepared during its recess, and heard oral testimony from some of the canal officials. The following day the public meeting was held, in accordance with the advertisement, but the only persons who attended were the president, the treasurer, and the engineer of the canal company, and the agent of the company for the sale of the lands donated for the construction of the canal.

The Board was unable to account for this indifference on the part of the public. In addition to the advertisement in the newspapers, several special letters of invitation were written to prominent persons, whose varied interests in the State would, it was supposed, naturally incline them to attend the meeting, if thus invited. Among these was the present member of the House of Representatives from the canal district. His presence was specially desired, as he is one of the present stockholders, and was one of the original incorporators of the canal company who advanced money for starting the work of canal construction. (Exhibit C.) The letters were not answered, and none of the gentlemen attended the meeting.

The public advertisement specially called for written statements of the views of mariners and others whose interests would be subserved by the abolition of the canal tolls, and by the assumption of the control of the canal and its improvement by the General Government. No letters from any source were received by the Board, and no mariners, ship-masters, or ship-owners attended the meeting.

One inference to be drawn from this apparent indifference of the public is that the canal tolls are not oppressive.

For a full understanding of this report the Board believes it will be of interest—as also required by the instructions—to give an account of the origin of the canal, and a condensed history of past legislation in regard to its construction, and of the operations which have taken place thereunder.

ORIGIN OF CANAL.

For the information under this head, the Board is largely indebted to the reports of committees on State affairs, Wisconsin legislature, published in the journal of the assembly February 21, 1879, and reprinted in the Report of the Chief of Engineers, United States Army, 1879, Part II, page 1194 *et seq.*; to reports of engineer officers in charge

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of rivers and harbors, Lake Michigan and Green Bay, and their assistants, from 1870 to 1886, inclusive, and to personal inquiries by the members of the Board made since the present investigation was ordered.

Green Bay is an extensive inlet, tributary to Lake Michigan on the northwest side, from which it is partly separated on the east by a peninsula 75 miles long, approximately, having an average width of 10 to 12 miles. The bay is 100 miles long in a northeast and southwest direction, 60 miles of which (northern part) lie within the State of Michigan and the residue in the State of Wisconsin. The width at the outlet is 30 miles, approximately, but the water-way there is choked by several islands and by submerged reefs and shoals, the channels through which have been regarded by mariners as exceedingly dangerous to shipping, though the main channel to the northward of Washington Island is 2 miles wide between the 10 fathoms curves, and is free from obstructions. On the south side of the entrance, through the passage known as "Death's Door," many disasters have occurred in time past, owing to the strong and irregular currents which exist there. This is a favorite passage for vessels, because it shortens the sailing distance. Near the center of the bay, on the east side, there is an inlet, called Sturgeon Bay, which is 8 miles long east and west, and 2 miles wide at the entrance. The narrow strip of land, 1½ miles wide, separating the eastern extremity of Sturgeon Bay from Lake Michigan, is the site of the Sturgeon Bay and Lake Michigan Canal, the subject of this examination.

The feasibility of cutting a canal through this isthmus was recognized early in the history of the territory, but no active steps for its execution were taken till 1856, when a company was legally incorporated with authority to "locate and construct a canal, to construct a harbor at the mouth, and to dredge a convenient channel in the bay."

The financial embarrassments which swept the country in 1857, and the enactment of a new State law in 1858, imposing alleged oppressive restrictions upon the company, caused it to pass out of existence before any work had been started. When the scheme was revived in 1864, it was claimed by the promoters that the building of the canal would materially diminish the annual losses to life and property, which vessels had previously suffered by shipwreck at Death's Door; that it would reduce the sailing distance 150 miles on each round trip between Green Bay and the southern part of Lake Michigan, and that the cost of transportation for lumber would be reduced 30 per cent. It was asserted that over 200 vessels of various classes navigated the bay, carrying a commerce consisting of lumber, shingles, laths, timber in its various forms, commercial and mill supplies, and iron ore, having an estimated valuation of $100,000,000 annually.

The fine tracts of pine and hard-wood lands, which border the bay, and the rich and extensive iron mines, then opening on the Menomonee River and its tributaries, furnished the materials for the exports; and the supplies for the mills and the laborers, and the commercial necessities for the young town springing up at the mouths of the water-courses furnishing the imports.

Over 100 mills, employing 15,000 men, were in active operation, with an invested capital estimated at $100,000,000.

These were important industries, which could not fail to attract the attention of the public, and when Congress was petitioned to aid in constructing the canal the appeal was answered in 1866 by a liberal grant to the State of Wisconsin of 200,000 acres of public land, to be selected from available lands nearest to the site of the proposed canal.

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The grant was believed at the time to be an especially valuable one; the greater part of the lands were located on the upper waters of the Oconto, Peshtigo, and Menomonee rivers, in Oconto and Marinette counties, Wisconsin, within 50 miles from the entrance to the canal, and over 100,000 acres contained some of the finest timber in the State.

From 60,000 to 80,000 acres of the grant, located chiefly in Door, Brown, and Kewaunee counties, were a poor grade of agricultural lands, with but little timber, and were rated as poor lands. As the finest tracts were located near the lake and its tributary streams, the timber readily found its way to the mills, where it was cheaply converted into salable articles of commerce, and thence distributed with facility and dispatch to the important trade centers at Milwaukee, Chicago, and elsewhere.

HISTORY OF THE CANAL CONSTRUCTION.

So far as concerns this inquiry, it will only be necessary to consider that part of the history of the canal scheme dating from the passage of the act of Congress approved April 10, 1866, which made to the State of Wisconsin a grant of public lands to aid in the construction of a canal to connect the waters of Sturgeon Bay and Lake Michigan.

The act is as follows:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be, and hereby is, granted to the State of Wisconsin, for the purpose of aiding said State in constructing and completing a breakwater and harbor and ship-canal to connect the waters of Green Bay with the waters of Lake Michigan, 200,000 acres of public lands, to be selected in subdivisions, agreeably to the United States survey, by an agent or agents appointed by the governor of said State, subject to the approval of the Secretary of the Interior, from lands subject to private entry: *Provided,* That said selections shall all be made from alternate and odd-numbered sections of land nearest the location of said harbor and canal in said State not otherwise appropriated, and not from lands designated by the United States as "mineral" before the passage of this act, nor from lands to which the rights of pre-emption or homestead have attached.

SEC. 2. *And be it further enacted,* That the said lands hereby granted shall be subject to the disposal of the legislature of said State, or, if the legislature thereof shall not be in session or shall adjourn within ten days after the passage and approval of this act, then said lands shall be subject to the disposal of the governor and board of commissioners* of school, university, and swamp lands of said State, for the purpose aforesaid and for no other; and the said canal shall be and remain a public highway for the use of the Government of the United States, free from toll or charge upon the vessels employed by said Government in the transportation of any property or troops of the United States.

SEC. 3. *And be it further enacted,* That before it shall be competent for said State to dispose of any of said lands, to be selected as aforesaid, the plan of said breakwater and harbor and the route of said canal shall be established, and a plat or plats thereof shall be filed in the office of the War Department, and a duplicate thereof filed in the office of the Commissioner of the General Land Office.

SEC. 4. *And be it further enacted,* That if the said breakwater, harbor, and canal shall not be completed within three years from the passage of this act, the lands hereby granted and remaining unsold shall revert to the United States.

SEC. 5. *And be it further enacted,* That the legislature of said State shall cause to be kept an accurate account of the sales and net proceeds of the lands hereby granted, and of all expenditures in the construction, repairs, and operating of said canal, and of the earnings thereof, and shall return a statement of the same annually to the Secretary of the Interior. And whenever said State shall be fully reimbursed for all advances made for the construction, repairs, and operating of said canal, with legal interest on all advances until the reimbursement of the same, or upon payment by the United States of any balance of such advances over such receipts from said lands and canal, with such interest, the said State shall be allowed to tax for the use of said

* The board of commissioners for the sale of school, university, and swamp lands was composed by State law of the secretary of state, the treasurer, and the attorney-general.

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canal only such tolls as shall be sufficient to pay all necessary expenses for the care charge, and repair of the same.

SEC. 6. *And be it further enacted*, That said ship-canal shall be at least 100 feet in width, with a depth of water not less than 13 feet.

Approved April 10, 1866.

By a State act published March 10, 1868, nearly two years later than the act of Congress, this grant, with all the restrictions and upon the terms and conditions contained in said act of Congress, was accepted by the State of Wisconsin, and transferred, subject to the conditions, restrictions, and obligations of the act of Congress, to a construction company, called the Sturgeon Bay and Lake Michigan Ship Canal and Harbor Company, which was organized, as the act says, in the city of Milwaukee, on the 4th day of October, 1866, in accordance with the State law of 1864. (Exhibit D.)

The State act of 1868 is as follows:

The people of the State of Wisconsin, represented in senate and assembly, do enact as follows:

SECTION 1. That the lands, franchises, rights, powers, and privileges granted to and conferred upon the State of Wisconsin by an act of Congress approved April 10, 1866, "granting to the State of Wisconsin a donation of public lands to aid in the construction of a breakwater, and harbor, and ship-canal at the head of Sturgeon Bay, in the county of Door, in said State, to connect the waters of Green Bay with Lake Michigan, in said State," be, and the same are hereby, accepted with the restrictions, and upon the terms and conditions contained in said act of Congress.

SEC. 2. For the purpose (of) carrying out the objects of said act the said lands are hereby granted and conferred upon the Sturgeon Bay and Lake Michigan Ship-Canal and Harbor Company, a company organized in the city of Milwaukee, on the 4th day of October, 1866, under and by virtue of chapter 365 of the laws of Wisconsin of 1864, approved April 24, 1864, subject to all the conditions, restrictions, and obligations herein mentioned.

SEC. 3. It shall be the duty of said ship-canal company to appoint an engineer, who shall proceed to survey, lay out, and establish the route of said canal, and determine the termination thereof, and also prepare a plan for the construction of said canal in conformity with the provisions of the said act of Congress, and make a diagram thereof, to be approved by the governor, and when approved by him the same shall be filed in the office of the secretary of state.

SEC. 4. It shall be the duty of the said company, after having made and filed such survey and plan of said canal, to proceed without unnecessary delay and construct the same in conformity therewith: *Provided*, That as the work on said canal progresses, the company may notify the governor that one-fourth or one-half or three-fourths of said work has been done, respectively, when upon receiving such notification, the governor shall appoint an agent to inspect the same, and if said governor is satisfied that so much of said work has been done in accordance with the requirements of this act and of the act of Congress aforesaid, then the said governor shall certify the same to said company and deposit a copy thereof in the office of the secretary of state, and in said certificate shall determine the proportion of said lands the said company has become entitled to in consideration of said work so done and approved by said governor, and when the governor shall make and file such certificate the commissioners of schools and university lands shall convey by patent to the said company said proportions of said lands, respectively, as selected by said company, and said company may proceed to sell and convey the same; and when the said company shall have completed the said canal in pursuance of the act of Congress and in conformity with said survey and plan it shall be the duty of the company's engineer to certify the same to the governor, whereupon it shall be the duty of the governor to inspect the said work in person or to appoint one or more agents to inspect the same and determine whether the said canal is constructed as required by this act. And whenever the said governor shall determine that the said canal has been constructed by the said company as required by said act of Congress, and in conformity with the plan aforesaid, he shall certify the same to said company and deposit a copy thereof in the office of the secretary of state, and which certificate, as well as any certified copy thereof or of any other certificates mentioned in this act under the seal of the State, shall be evidence of the facts therein set forth. And when the governor shall make and file with the secretary of state such certificate and deliver a copy of the same to the said company, the remainder of the said lands shall be patented by the commissioners of school and university lands to the said company, which shall stand seized and possessed of all said lands as fully as the State

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can convey the same, and free from any tax for the term of ten years, if so long held by the said company, and the said company shall use all due diligence in disposing of said lands at a fair and equitable price, and they shall not be held by the said company for speculation, and when sold by said company they shall be subject to taxation: *Provided*, That previous to the issue of a patent therefor or for any of said lands, said company shall reimburse the State for all expenses incurred on account of the same.

SEC. 5. All expenses incurred under and by virtue of this act, and of the act of Congress aforesaid, shall be paid by the company, and the State shall not in anywise be holden therefor.

SEC. 6. This act shall take effect and be in force from and after its passage.

Approved March 5, 1858.

The canal company was incorporated, it is said, to comply with section 10, Article VIII, of the constitution of the State of Wisconsin, which reads as follows:

The State shall never contract any debt for works of internal improvement, or be a party in carrying on such works, but whenever grants of land or other property shall have been made to the State, especially dedicated by the grant to particular works of internal improvement, the State may carry on such particular works, and shall devote thereto the avails of such grants, and may pledge or appropriate the revenues derived from such works in aid of their completion.

It was decided, on January 4, 1860 (10 Wis., 195), in the case of Bushnell *vs* Beloit, under this section, that—

The State legislation may authorize that to be done by another which the State can not itself do by reason of a prohibition in the constitution. This principle is based upon the unrestricted power in the legislature to create corporations or allow individuals to do acts inhibited to the State to engage in.

By the acceptance of the grant of public land from the Government for the specific purpose of aiding in the construction of the proposed canal and breakwater the State of Wisconsin accepted a trust, as the Board believes, which it was under obligation to see faithfully executed in furtherance of the particular work mentioned in the grant. And it does not appear that there is anything in its constitution or laws to have prevented the State from accepting the lands, selling them according to State laws, and applying the proceeds of the sale to the construction of the canal, though it may have been more convenient to incorporate a special company to relieve the State from the trouble and care incident to such an enterprise.

The first paragraph of section 2 and the last paragraph of section 5, act of Congress, April 10, 1866, seem to indicate that Congress expected that the State would assume the duty of selling the lands, and apply the proceeds in the execution of the work.

The question here arises whether the canal company, on its incorporation, became simply the agent of the State, and when its work was completed naturally passed out of existence, and the canal improvements should not have become the property of the State, with such incumbrance attached as the construction property entailed.

If the company had not been reimbursed for its legitimate outlays, at the time of completion of the canal, it was the duty of the State to audit the accounts, inclusive of the sales of the lands granted for construction, and to make an equitable adjustment with the company.

The act of Congress, April 10, 1866, required the canal to be constructed within three years from the passage of the act, otherwise the lands so granted would revert to the public domain. On the expiration of this limit, April 10, 1869, no work of construction of any kind had been done by the canal company.

On the first of March, 1872, the United States grant was revived, and its provisions were extended by Congress to April 10, 1874, and in ac-

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cordance therewith work was begun July 9, 1872; but on the expiration of the limit of the extended grant, the first quarter of the canal had not been completed, nor had any patent for any portion of the land been issued. The canal company suspended operations from 1874 to 1877; in the latter year work was resumed, and prosecuted to completion in November, 1881. The certificate of the governor on the completion of the canal was dated December 5, 1881, or seven years and eight months after the expiration of the time as extended by Congressional act, and fifteen years and eight months after the passage of the original act of Congress, April 10, 1866.

The lands constituting the Government grant were patented to the canal company by the State authorities in four sections, one section at a time, on acceptance by the State of each one-fourth completed section of the canal.

The canal, when declared completed by the State, December 5, 1881, was 7,400 feet long, 100 feet wide at the water's surface, and from 11 to 13 feet deep, estimated from the plane of low water of 1847. The 3,200 feet adjacent to Lake Michigan were revetted on both sides with sheet-piling; the next 900 feet to the westward were protected on both sides with brush and a few piles, and the remaining 3,300 feet adjacent to Sturgeon Bay were left without any kind of protection.

From the western end of the canal, for a distance of 6,100 feet into Sturgeon Bay, a channel had been excavated of a width and depth equal to that in the canal; and in Lake Michigan, north and south of the canal entrance, the shore line had been protected by a few hundred feet of timber work, filled with stone, to prevent deterioration of the canal entrance.

The canal company did no work towards the construction of the "breakwater and harbor" mentioned in the original act of Congress making a donation of public lands by which the canal construction was executed. All the improvements in Lake Michigan at the canal entrance, except a small amount of dredging by the canal company to secure 13 feet depth on the approach to the canal, was done by the Government. These governmental improvements were begun in 1873, under an act approved March 3, 1873, which appropriated $40,000 for a "harbor of refuge at Lake Michigan entrance to the canal." This act and those passed subsequently have relieved the State of Wisconsin of the obligation imposed by the original act of building "the breakwater and harbor" in Lake Michigan. The estimated cost of the so-called harbor of refuge was $180,000, of which sum $160,000 have been appropriated and expended to date.

So far as built, the works constituting the protection to this canal entrance consist of two oblique piers of pile-work, filled with stone, starting from the shore-line 350 feet north and south of the entrance, and converging towards each other at a distance outwards of 1,100 feet, so as to leave an opening between their outer ends of 235 feet in the clear. The space inclosed by the piers measures about 14 acres, and has been dredged by the Government to afford 12 to 13 feet at low water. The harbor of refuge, so called, is a harbor in name only, but *does* serve to protect the canal entrance. When the seas are rough vessels can not anchor there, and must pass through the canal to a harbor of refuge in Sturgeon Bay. The narrow width of the canal forbids its use at such times for the accommodation of vessels. All must go inside.

To provide in Lake Michigan a secure entrance to the canal and passage thence to Sturgeon Bay, works must be built (and channel exca-

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vated to 18 feet depth) exterior to existing works, at a probable cost of $700,000 to $1,000,000.

The nature and location of such works have not been studied in detail for want of the information to be derived from further surveys and observations.

The above sum is so large that it seems proper to state it in this connection for the information of Congress when considering the expediency of the Government's assuming control of the canal and its future improvement.

An examination, section by section, of the original act of Congress approved April 10, 1866, will show how the State of Wisconsin has performed its trust toward the Government, and how the canal company has carried out its obligation to the State.

Section 1.—A land map, containing the location of the selected lands, was presented for the examination of the Board by the canal company, which indicated that all the lands lay within a circle having its center at canal entrance on Sturgeon Bay, and described with a radius of 50 miles. Some of the lands were noted in isolated quarter-sections, while others were in large bodies, more or less widely separated. It would have been impracticable now to test the accuracy of the selections.

Section 2.—The action taken by the State of Wisconsin on the act of Congress, April 10, 1866, was delayed for nearly two years after the passage of the act, and was then legislative. The provisions of this section appear to have been complied with.

Section 3.—This section was only partially complied with. On May 2, 1867, a map showing "route of said canal and the plans of the breakwater and harbor" was filed, with letter from the governor. April 29, 1867, in the office of the Commissioner of the General Land Office. On March 10, 1873, a second map, in lieu of the one approved and filed in 1867, was filed, showing "the plans of the piers for the harbor and the route of the canal" (Exhibit X, Map A). The first map filed gave drawings and specifications for a canal 100 feet wide at the bottom, with revetted banks throughout and a harbor in Lake Michigan, while the second map showed only the route of the proposed canal and a new form of protection of canal entrance, and omitted to give any details of construction (Exhibit X, Map B).

Section 4.—It has already been stated how this section has been ignored. Notwithstanding the act of Congress required the canal to be completed within three years after the passage of the act under penalty of a reversion to the United States of the lands unsold, the canal company did not commence operations till six years thereafter. In the mean while, however, the limit of completion had been extended by Congress to April 10, 1874. When this last date was reached the canal company had not completed one-fourth of the construction, and therefore had not become entitled to any land under the State act of acceptance of the grant, and no patent had been issued.

Congress passed no subsequent law extending the grant, though a memorial (Exhibit I), dated February 6, 1877, was sent to Congress by the legislature of the State of Wisconsin, asking for an extension of three years and for an appropriation of $100,000 in money.

This memorial says that—

> Owing to the depreciation of said grant in consequence of the destructive fire of 1871, which destroyed much of the timber thereon, * * * the company has been unable to raise means to prosecute the work.

Attention is invited to the fact that the appraisal of the grant by a commission, of which the president of the canal company was a member, was made in August, 1874, threeyears after the said fire (Exhibit F).

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It is now stated by the canal company that no further effort was made for the extension of the land-grant act, as the circuit court of Minnesota had decided in the case of Saint Croix Railroad grant (Dillon's C. C. Rep. Dist. Minn., 1872, p. 398), that—

Such lands do not, *ipso facto*, revert to the United States by mere failure to build the road (railroad grant) within the period prescribed in the act of Congress; to effect the forfeiture, some act on the part of the General Government evincing an intention to take advantage of such failure is essential.

Here arises a question of law which the Board does not feel competent to decide upon, and therefore limits itself to a simple statement of the facts.

Section 5.—This section was not complied with (Exhibit A). From the very nature of the grant of land which was made to aid in the construction of the canal, the payment of money by the Government on assuming charge of the canal, to the State in reimbursement with legal interest for alleged advances by the State in excess of net receipts from land sales, presupposes that the State has carefully audited the accounts for sales of lands and for construction, and approved them as well as the methods pursued by the canal company in either particular. The State did not, in fact, audit any account either of construction or sale of land

This subject will be further considered under the head of "cost of construction."

Section 6.—This section was not complied with, for its provisions require that the said ship-canal should be 100 feet wide, and not less than 13 feet deep. The phraseology of the section might, on first reading, appear somewhat vague, but the obscurity disappears when it is carefully examined with reference to the requirements of a navigable width for a ship-canal.

The interpretation given to it by Maj. D. C. Houston, Corps of Engineers (Report Chief of Engineers, 1872, page 171), namely, that the required width should be measured on the *canal bottom*, should be kept in mind when considering the State decision which defined the dimensions for the canal.

The river and harbor act approved March 3, 1871, contained provision for a

Survey for a ship-canal from the head of Sturgeon Bay, Wisconsin, on the line now opened across the Portage through the timber to the shore of Lake Michigan, with estimates for constructing the same 100 feet wide and 13 feet deep.

It will be observed that this act was passed over one year before the Sturgeon Bay and Lake Michigan Canal Company began work under the State act of 1868 accepting the Government land grant. It is not known under what influences the direction of this survey to be made by the United States was incorporated in the law, but the effect was to relieve the canal company of the expenses of a detailed survey, the preparation of the necessary charts, and the formation of the estimates for the cost of the canal construction. The survey was made during the summer of 1871, under the direction of Major Houston, Corps of Engineers, who says in his report (Report Chief of Engineers, 1872, page 171), that "the proposed canal, for which estimates are submitted, is 100 feet wide *at the bottom*, and 13 feet deep."

The language of the act of April 10, 1866, is identical with that of March 13, 1871, in regard to the dimensions of the canal, and Major Houston interprets the language, referring to width, to mean 100 feet wide at the bottom. No exception seems to have been taken to this interpretation by any one in authority.

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The line of the canal route recommended by Major Houston was practically adopted by the State, but the majority of the committee on State affairs, Wisconsin legislature, under date February 21, 1879 (Report Chief of Engineers, 1879, Part II, page 1496, Exhibit H), report that the canal company did not adopt the Government plans and specifications, but others which provided for a canal 100 feet wide *at the water's surface* and 13 feet deep. The reason given for this change was that the State had been disappointed in securing an additional land grant from the Government.

The change was therefore dictated by economy, at the expense of canal efficiency. The canal as eventually completed was neither 100 feet wide at the bottom nor 13 feet deep throughout.

The canal company was not in ignorance of the Government plans and specifications, for its chief engineer, who had charge of all the work done on the canal, from the beginning to the end, was Mr. William T. Casgrain, who had made in 1871, under the direction of Maj. D. C. Houston, the first detailed survey across the isthmus, by which was determined the most feasible route for the canal, and had prepared the estimates for the cost of construction.

COST OF THE CANAL CONSTRUCTION.

The Sturgeon Bay Canal is an open cut, without locks or gates, and the unstable banks are revetted for only a part of the canal length. The canal company has no visible property there except the canal itself. The original acts of the State of Wisconsin, March 10, 1868, and succeeding acts on the same subject, constituted, and in effect recognized, a contract with the canal company to do for the State a certain specified work for the consideration mentioned in the original act, viz, the grant of 200,000 acres of public lands.

The cost of the canal construction was made the subject of an examination by a Board of Engineers, constituted by Special Orders, No. 51, Headquarters Corps of Engineers, Washington, D. C., June 6, 1882, in obedience to a resolution of the Senate of the United States, March 9, 1882. We respectfully invite attention to the report of that Board, with its accompanying papers (Report of Chief of Engineers, 1883, Part II, page 1657, Exhibit A).

It is learned therefrom, on the statement of the governor, that the legislature of the State of Wisconsin had failed to comply with section 5 of act of Congress of 1866, which required that the said "legislature should cause to be kept an accurate account of the sales and net proceeds of the lands" granted by the said act, and of "all the expenditures in the construction, repairs, and operating of said canal, and of the earnings thereof, and shall return a statement of the same annually to the Secretary of the Interior."

The details of the sale of the lands and the construction of the canal were imposed entirely upon the Sturgeon Bay Canal Company, and they alone possessed the records relating to the net proceeds of the lands and the cost of construction of the canal.

The information which the present Board has received in regard to the canal excavations has been derived from written statements from the canal company. Independent computations have also been based on the original survey of 1871 and on two subsequent surveys, one made by direction of the Board of United States Engineers in 1882, and the other under the direction of this Board in September, 1886.

The low-water reference for the year 1847 was adopted in the preparation of the charts of the three surveys, so that the computations for the

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excavations required along the line of the canal and in the bay could be easily made for comparison.

The following are the results obtained:

ESTIMATE OF EXCAVATIONS REQUIRED TO MAKE A CANAL 100 FEET WIDE AT BOTTOM AND 13 FEET DEEP, REVETTED THROUGHOUT, AFFORDING APPROACHES OF EQUAL WIDTH AND DEPTH FROM BAY AND LAKE.

1871. Survey by Maj. D. C. Houston, Corps of Engineers:

Excavations, wet and dry, in situ .....cubic yards.. 895,000

ESTIMATES OF THE EXCAVATIONS REQUIRED TO BE MADE TO GIVE THE CANAL AS IT EXISTED IN 1882 AND 1886, BASED ON SURVEYS MADE IN THOSE YEARS, RESPECTIVELY, BY DIRECTION OF THE BOARD OF ENGINEERS.

1882. Survey by Maj. H. M. Robert, Corps of Engineers:

Excavations, wet and dry, in situ .....cubic yards.. 1,039,000

1886. Survey by Capt. C. E. L. B. Davis, Corps of Engineers:

Excavations, wet and dry, in situ.....cubic yards.. 1,064,441

The canal company claims that in excavating a canal 100 feet wide at the water-surface and 13 feet deep, only partially revetted, the excavation equaled 1,147,624 cubic yards.

It is here noted that the number of cubic yards paid for by the company exceeds the amount of the estimates for the work, and in this connection several circumstances are to be mentioned. The canal as excavated was smaller than as estimated for. The official inspector, Mr. Nader, reported to the governor of Wisconsin (Exhibit P) that in one portion of the work the excavation was not well managed. The great fire in Chicago destroyed most of the Government records, and some of the estimates are prepared from incomplete data. These attempts at explanation of discrepancies are made in fairness to all concerned.

The written certified statement furnished by the canal company (Exhibit A) shows that the disbursements, which might have been legitimately charged against continuous canal construction account to October 10, 1882, were $342,762.99; but this amount includes $36,510.61 for overseeing and incidental expenses, chief engineer, from May 5, 1872, to December 3, 1881, calculated without rebate for the three years, 1874–1877, during which work was suspended, when in the opinion of the Board all expenses should have been stopped. The means provided for the work amounted to $406,335.51, including the net proceeds arising from the sale of the Government land grant, amounting, by the company's statement (Exhibit A), to $344,687.17 (after deducting the expenses of the land department, $33,278.05); the insignificant subscription to the capital stock of the canal company amounting to $2,665, and the sum of $58,983.34 temporarily loaned, 1872 and 1873, by the stockholders to the company.

The company borrowed in 1876 from the Third National Bank, New York City, $41,500, but this sum was repaid, with interest, August 22, 1878, out of sales from lands, and should not enter the expense account.

The year 1874 was the critical period in the experience of the company. It had received in September a patent for 32,347 acres of fine timber land, but the financial depression throughout the country gave a poor demand for it, and it was found impracticable, owing to the stringency of the money market to raise money by mortgages. The result was that the company suspended work until 1877, during which year sales were made, after public advertisement, by auction or otherwise, and the sum of $95,922.67 was realized, including $4,977.51 from tres-

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passes upon land grant. The company was thus enabled to liquidate all outstanding liabilities and to resume work under favorable auspices.

The sales of the succeeding land patents, notwithstanding the low prices at which the last 70,000 acres were disposed of, made ample provision for carrying the work to completion without the necessity for further loans from the stockholders.

In the company's account (Exhibit A) it will be noticed that these loans, which aggregated $58,983.34, were capitalized into stock at par September 10, 1873, and 10 per cent. compound interest computed thereon to December 1, 1882, by which the original sum of $58,983.34 was swollen to $140,383.58.

The time actually consumed in work was about six years, but it was not continuous, and the methods pursued made the expenses unnecessarily large. The work was done at irregular intervals during nine years or more with the evident determination of the canal company that the proceeds from the sales of the land grant should provide the working capital, and that assessments upon the stockholders should be made only when such advances became absolutely essential to hasten to completion an additional one-fourth part of the canal excavation for the procurement of an additional patent of land.

This method of doing work involved a hasty and injudicious sale of the land; it relieved the company from using the private money of the stockholders, but at the same time reduced its ultimate assets, and besides prolonging the work gave rise to unnecessary expenditures for salaries, office expenses, etc.

The long delay in constructing the canal, and the apparent indifference of the public to the matter at the present time, lead the Board to think that the importance of this port to the *general* commercial interests of that section have not been as great as have been sometimes represented, and that there was a speculative interest in the land grant which had no connection with commerce.

The land was sold by the canal company. Before any sales were made the land was appraised by intelligent commissioners, one of whom is now president of the company. The amount of the appraisal was nearly $600,000. The net proceeds of sales were less than $350,000. Whether a greater sum would have been realized had the lands been sold directly by the United States or by the State of Wisconsin can not be known. It is believed, however, that it would have been very much better had that method of sale been adopted and nothing done on the work upon the canal until a sufficient sum should thus have been obtained for beginning and probably completing the canal; and there would have been no such lien on the canal as is now presented, which consists of advances by members of the company, with interest heavily compounded thereon.

The first two patents of land issued to the company called for 100,000 acres, or one-half the grant, at an appraised valuation of $341,905.46, the residue of the grant being appraised at $235,677.98. The lands were not of equal value, and were grouped into four classes, the value per acre of land in each class being appraised at $4.50, $3.50, $2.50, and $1.50, respectively, and each patent issued was made up of a certain proportion of land selected by the canal company from each class (Exhibit F).

The committee appointed by the State legislature in 1876 to investigate the subject of land selections reported (Exhibit G) that the "first and second classes were appraised too low, and the third and fourth classes too high," and that the grant was "ample to complete the work." However this may be, the company seems to have selected first the

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lands which would have the readiest sale, and the first three patents contained, it is believed, all the lands which were of special value.

The canal construction and maintenance account should stand as follows (Exhibits A and B):

RECEIPTS.

Net receipts from lands (Exhibit A) October 10, 1882	$344,687.17
Net receipts from lands (Exhibit A) October 10, 1882, to October 1, 1886	1,193.61
Canal tolls, January 1, 1882, to October 10, 1882	14,016.76
Canal tolls, October 10, 1882, to October 1, 1886 (Exhibit B)	73,343.41
Total	433,240.95

DISBURSEMENTS.

For construction to October 10, 1882 (Exhibit A)	$342,762.99
Canal operating expenses to September 1, 1882 (Exhibit A)	8,542.30
Canal operating expenses from September 1, 1882, to October, 1886, repairs, land department, and salaries, etc. (Exhibit B)	26,432.24
Total	377,737.53
Net receipts in excess of legitimate disbursements	55,503.42

After the acceptance by the State of the land grant, and during the process of construction of the canal, the Government of the United States expended $3,589.46 in making a survey and estimates for canal construction, and $160,000 in building, on Lake Michigan, works for the protection of the canal entrance, and has appropriated $20,000 more for the same object.

These obligations were imposed upon the State by the original act donating the land, and their subsequent assumption by the Government may be regarded as additional bounties to the State.

There are no returns for tolls collected during the years 1879, 1880, 1881, before the canal was turned over to the State, but the records (Exhibit W) show that 547,852 tons passed through during those years, which, at 3 cents per ton, the lowest rates, would give $16,435.56, exclusive of towage. The net proceeds from canal tolls and towage from January 1, 1882, to October 1, 1886 (Exhibit B), were $87,360.17, and the disbursements for operating and repairs were $30,438.43, leaving a credit balance on this account, for the years 1882–1886, of $56,921.74. During the years 1882–1886, the sum of $64,149.20 was paid to the stockholders of the canal company (oral statement of treasurer of canal company), in reimbursement for the loans made in 1872–1873, to the company to enable it to complete the first quarter of the canal construction. The balance to the credit of the canal company October 1, 1886, was $10,712.99, including $6,156.36 cash in bank (Exhibit B).

The Board agrees with the Board of 1882 (Report Chief of Engineers, 1883, Part III, page 1661) in saying that the object of section 5 of act of Congress April 10, 1866, could be entirely defeated if salaries for the various officers of the Sturgeon Bay Canal Company could be charged as an essential part of the expense of the State for the "construction, repairs, and operating of said canal."

As the United States, by going beyond the original intent of the grant (which if well managed might have sufficed to complete the canal), constructed an entrance to the canal at a cost of more than $160,000, thereby making the property a more valuable one than it otherwise would have been, except through an equal outlay by the company, is not the United States then entitled to an equitable proportion of the

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annual proceeds of the use of the canal? And should not this outlay be a fair offset to the claim of the company to reimbursement to the extent of $150,000 as proposed in the Senate of the United States at its last session, especially as this large sum has been mainly piled up by illegal compound interest, and the real cash advances have been nearly already reimbursed?

COMMERCIAL CHARACTER OF CANAL.

There is a narrow channel through the canal, as constructed, which has a depth of nearly 13 feet, low-water stage 1847, which is equal to the depth sought to be obtained at the principal improved harbors on Green Bay, but is 3 feet less than that which commerce requires for the large ports on the Great Lakes. The tonnage which has heretofore passed through the canal is believed to have been almost exclusively by vessels, barges, and tows employed in transporting the products of the mills located on Green Bay, or the supplies necessary for their maintenance, and those for the population dependent upon the lumber interest.

It would be interesting to separate the tolls into two sums; one consisting of the amounts paid by vessels belonging to or in the service of persons connected with the canal company; and the other of the amounts paid by vessels using the canal because of its advantages, in time and convenience, and sometimes in safety, over the old longer way between Green Bay and Lake Michigan. This could only be done by a careful analysis of the information supposed to be contained in the toll-records of the company, which the Board has not.

Since the yield of timber on Green Bay has diminished, and the mills have begun to locate their pile yards near the points of manufacture for the shipment of their products direct by rail to the points of demand, the tonnage for this class of exports has decreased, and the advantages of the canal to the mill companies have proportionately declined. It is, therefore, not a matter of surprise that the time has come when the subject of transferring the canal to the Government, for maintenance and repair, should be agitated.

In the near future some disbursements for repairs and dredging may be expected for which present or increased tolls may be inadequate and would call for advances from the canal company—if the control remains vested in it—and those it would probably be unwilling to meet.

The result would be a lessening of the value of the canal and of the benefits arising from its construction. The extensive country rich in minerals, tributary to Green Bay on the north and northwest, and that which may be made tributary to it by the completion of the projected Fox and Wisconsin Canal and River Improvement (now nearly finished westward to Montello, Wis., only, with 6 feet water, distant 131 miles from Green Bay), will always make of Green Bay an important commercial highway, and of the Sturgeon Bay Canal a valuable line of intercommunication with Lake Michigan, which should be as free to shipping as any of the channel-ways connecting the Great Lakes.

The Board is fully sensible of the advantages, present and prospective, of the Sturgeon Bay Canal, but it can not omit saying that without extensive improvements to it and at its outlet into Lake Michigan, already alluded to, it will never be utilized in a great degree as a harbor of refuge. Admitting that it could be entered by vessels of 13 feet draught or less in a storm without any additional improvements—which would be very hazardous—the capacity of the canal is too restricted to

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allow vessels to anchor or tie up in it; they must all go into Sturgeon Bay for shelter.

While the canal is not a harbor of refuge, it is a means of access to such a harbor in Sturgeon Bay. In this respect its utility depends upon the ease and facility with which vessels can enter it.

Sturgeon Bay is a harbor of refuge of rare and exceptional value, but is of chief advantage to the vessels belonging in Green Bay, whose sailing courses always find them, on the gathering of a storm, close inshore, accessible to the canal entrance.

A harbor of refuge for vessels navigating Lake Michigan, and passing to the other larger lakes, is needed on the west side of Lake Michigan, between Porte des Morts and Milwaukee; and the construction of extensive works, exterior to those now at the entrance to Sturgeon Bay Canal, the enlargement of the canal, and the excavation of a convenient basin, would convert Sturgeon Bay into a secure place of shelter for the largest vessels of the lakes, whose benefits would be enjoyed at one time or other by the greater part of all the shipping which ever comes to Lake Michigan.

The data for giving a close estimate of the cost of the work herein outlined are incomplete and imperfect, and the Board only alludes to these accessory improvements as one of the probabilities of the future, which may follow the assumption of the control of the canal by the Government.

The tonnage of the canal gradually increased (Exhibit W) from 32,071 tons in 1879 to 745,000 tons in 1882, and then in turn declined gradually till it became 376,605 tons for 1886, returns estimated to October 1. It is not probable that the present tonnage will be much changed during the next few years, as the decline in the lumber tonnage will be doubtless compensated for by that due to the gradual increase in the population of the tributary districts, and in the extension of the manufacturing and mining industries.

It would be advisable, in view of the growing need of a harbor of refuge on the west side of Lake Michigan, for the Government to assume full and complete control over the canal, its future improvement and maintenance, provided the United States may be guarantied freedom from all liability for any expenses incurred by the State of Wisconsin, or by the canal company, in the construction of the canal, as it exists to day, whether represented by capital stock or any other kind of lien. If any legal or equitable incumbrance exists for which the canal or any of its improvements are security or guaranty, the said incumbrance should be removed by the State before the Government assumes control of the canal to make it a free highway, and appropriates money for enlarging it to fit it for an available approach to a harbor of refuge in Sturgeon Bay.

This recommendation is based upon the belief that the money realized from the sales of the land grant and from the tolls collected since the canal was opened have been ample, if economically and advantageously used, for the construction and maintenance of this work of improvement.

In conclusion, the Board would call attention to the fact that it is informed a bridge is about to be erected under State law over this waterway, with such an arrangement as to seriously interfere with navigation.

CONCLUSIONS OF THE BOARD.

(1) If the peninsula between Green Bay and Lake Michigan were now in the same natural condition as on the 10th of April, 1886, the construc-

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tion of a canal between them, on or near the line of the existing canal, would be a proper work to be done by the United States in the interests of commerce and navigation; but the United States should not be made to become responsible for an insufficient canal, encumbered with a heavy lien, results due to an inefficient agency not contemplated by the original act or recognized by any subsequent act of Congress.

(2) The grant of land donated to the State of Wisconsin, act of April 10, 1866, was sufficient to have built the Sturgeon Bay and Lake Michigan Canal, and should the Government assume control of the canal, no payment will be due, equitably or legally, for the construction and maintenance of the canal.

(3) The existing depth of 13 feet in the canal is not adequate to the demands of the largest class of vessels on the Great Lakes, and therefore the canal, as it now exists, has only a restricted importance.

(4) The canal is not a harbor of refuge in any proper sense, and at best is only an approach to a sheltered bay which is capable of conversion into a harbor of refuge.

(5) Sturgeon Bay is the true harbor of refuge, and, to make it available as such, an ample basin should be excavated, the canal deepened, and works constructed in Lake Michigan exterior to the existing works of protection at the canal entrance.

The conversion of Sturgeon Bay into a harbor of refuge accessible through the Sturgeon Bay Canal to all vessels which navigate the Great Lakes, would add great security to their shipping, and may be regarded as a public necessity.

(7) Whether the Government assumes control of the canal or not, the tolls collected on the vessels using it should not exceed the actual cost of operating and maintaining the said canal.

LIST OF PAPERS AND CHARTS ACCOMPANYING THIS REPORT.

* Exhibit A.—Report of Board of Engineers, 1882, and accompanying papers.
* Exhibit B.—Financial statement of the canal company, 1886.
* Exhibit C.—Statement of capital stock and indebtedness of the canal company.
* Exhibit D.—Copy of act of legislature, State of Wisconsin, April 24, 1864, incorporating the canal company.
* Exhibit E.—State act, 1873, amending State act, April 24, 1864.
* Exhibit F.—Commissioner's appraisal of land grant, 1874.
* Exhibit G.—Report of investigating commission, 1876.
* Exhibit H.—Report of investigating committee, 1879.
* Exhibit I.—Memorial to Congress from legislature, State of Wisconsin, February 6, 1877.
* Exhibit K.—List of lands selected by the canal company, approved by the Interior Department, May 3, 1867.
* Exhibit L.—List of land sales.
* Exhibit M.—Letter of Colonel Craighill to the Chief of Engineers, referring to the filing of certain maps in the War and Interior Departments by the governor of Wisconsin.
* Exhibit N.—Reply of the Commissioner of the General Land Office, enumerating the maps filed.
* Exhibit O.—Reply of the Chief of Engineers, enumerating the maps filed in the War Department and the office of the Chief of Engineers.
* Exhibit P.—State inspector's report to the governor of Wisconsin, December 30, 1878.
* Exhibit Q.—Estimate for canal excavation, 1886.
* Exhibit R.—Estimate for deepening canal and Sturgeon Bay to 18 feet.
* Exhibit S.—Statement of vessels passing through and taking refuge in the canal, 1885.
* Exhibit T.—Rates of toll charges by the canal company.
* Exhibit U.—Rules and regulations of the canal company.

* Omitted. Printed in House Ex. Doc. No. 106, Forty-ninth Congress, second session.

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* Exhibit U 2.—Chicago, 1871–'84. Fluctuations in prices, with remarks.
* Exhibit V.—Commercial statistics of Green Bay harbors, 1872–'85, inclusive.
* Exhibit.—Commercial statistics of the canal, 1879–'86, included in Exhibits A and B.
† Exhibit X.—Copy of maps (A and B) filed by the canal company with the Department of the Interior.
† Exhibit Y.—Copy of map (C) filed in Madison, Wis., 1872, by the canal company, showing the final location of the canal.
† Exhibit Z.—Copy of map showing the relations of the canal to Sturgeon Bay and Lake Michigan.
† Fxhibit Z 2.—Copy of map of the survey of the canal, 1886.
† Exhibit Z 3.—Copy of Lake Survey Chart of the north end of Lake Michigan, 1867.

Respectfully submitted.

WM. P. CRAIGHILL,
Lieut. Col., Corps of Engineers.
G. L. GILLESPIE,
Lieut. Col., Corps of Engineers.
W. L. MARSHALL,
Captain of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

G G 14.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

Estimated cost (see Report Chief of Engineers for 1876, Part II, pages 346–359 $175,000
Appropriated 155,000

Previous to the improvement of this harbor the depth of water at the mouth of the Wolf River was only about 2 feet.

The lower portion of the river was approximately normal to the trend of the lake shore until within about 60 feet of the lake when it turned abruptly to the northward nearly at right angles to its previous course and emptied into the lake about 300 feet above the location of the present piers.

The project of improvement adopted in 1875 provided for the formation of a small artificial harbor, connected with the lake by a channel 100 feet wide and 12 feet deep, to be formed by the construction of two piers extending from the shore-line to the 18-foot contour in the lake; also blasting and dredging rock from the river-bed near its mouth for a distance of 750 feet.

In accordance with a modification of the original project approved September 27, 1884, the cribs sunk in extension of the piers have been placed 50 feet further from the center line of the channel than the old piers, and will afford, when completed, a 200-foot entrance between the pier-heads.

The artificial channel should be extended a short distance above the present site of the highway bridge, which the city in that event will move to a point higher up.

From the commencement much trouble has been experienced in carrying on the work at this harbor, owing to the fact that a private party

* Omitted. Printed in House Ex. Doc. No. 106, Forty-ninth Congress, second session.
† Omitted.

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claims to own the entire site of the harbor from the piers up to the highway bridge. This man was the owner of a landing-pier, from which he derived a handsome revenue before the Government undertook the improvement of the harbor. He has built a warehouse just in the rear of the south pier, and has continued to make his own charges for all goods shipped by the steamer which stops there three times a week. As Ahnapee has no railroad communication and as this man man claims to own the land on both sides of the river, no one can reach the piers except as he may direct.

This has been the subject of various official reports (see Ex. Doc. No. 259, H. R., Forty-eighth Congress, second session; also Annual Reports of Chief of Engineers for 1877, 1878, and 1885).

It was doubtless due to those reports that the river and harbor act of August 5, 1886, appropriating $15,000 for continuing the improvement of Ahnapee Harbor, contained a proviso that none of the money so appropriated should be expended until wharfage over the Government piers should be made free.

The effort of the citizens for free wharfage have been unsuccessful, and consequently there have been no operations carried on at this harbor during the past fiscal year.

In 1884 two cribs were sunk in extension of the north pier and three in extension of the south pier. These cribs are 50 feet further from the center line of the channel than the old piers, and, having no superstructure, are very dangerous obstructions.

It is very desirable that work at this harbor should be resumed, and it is recommended that the proviso about free wharfage be omitted from future appropriations, as, after the channel has been excavated above the present site of the bridge, steamers can land above the limits of the land now claimed by the owner of the warehouse, and his monopoly will then be ended.

The present project is for the removal of rock up to the bridge only. The citizens have continued rock excavation some 200 feet further up the river, making a channel about 30 feet wide and 7 feet deep.

Whenever work is resumed at this harbor a modification of the project is recommended, with a view of making the channel above the bridge 50 feet wide and 12 feet deep, and that drilling and blasting at first be confined to the improvement of the channel begun by the citizens.

The estimated cost of the extension is as follows:

5,880 cubic yards rock excavation, at $2.75	$16,170.00
6,288 cubic yards mud excavation, at 16 cents	1,006.08
Superintendence and contingencies	1,823.92
Total	19,000.00

The percentages of work under the approved project accomplished are—

Pier construction:		
Substructure		87
Superstructure		76.4
Dredging, sand, etc		60
Rock removal		76
Length of north pier, June 30, 1887	feet	900
Length of south pier, June 30, 1887	do	1,125
Rock removed to June 30, 1887	cubic yards	22,233
Sand, etc., removed to June 30, 1887	do	82,343

With the funds asked for the fiscal year ending June 30, 1889, it is proposed to continue the work of blasting and pier construction.

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Money statement.

July 1, 1886, amount available	$501.39
Amount appropriated by act approved August 5, 1886	15,000.00
	15,501.39
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	67.97
July 1, 1887, amount available	15,433.42
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Ahnapee, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Sturgeon Bay Canal, Wisconsin.

(1) Amount expended to June 30, 1887 ..... $139,566.56
Amount required to complete improvement 20,000.00
Annual cost of preserving and maintaining 5,000.00

(2) Amount of commerce and navigation when work of improvement began in 1871.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1871.

Vessels arrived and cleared

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steam vessels	107	27,100	107	27,100
Sailing vessels	203	53,900	201	53,785
Total	310	81,000	308	80,885

Principal articles of import:

Lumber	feet, B. M.	10,000
General merchandise and provisions	pounds	1,725,000

Principal articles of export:

Posts and railroad ties	number	390,000
Grain	bushels	50,000
General merchandise and provisions	pounds	63,150

(3) Amount of commerce and navigation at present time.

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1886.

Vessels arrived and cleared.

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steam vessels	290	83,150	289	83,100
Sailing vessels	364	87,100	362	87,000
Total	654	170,250	651	170,100

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Principal articles of import:		
General merchandise and provisions	pounds..	10,625,000
Hardware, iron, and steel	tons..	500
Coal	do....	325
Principal articles of export:		
Brick	number..	150,000
Grain	bushels..	400,000
Eggs	dozen..	100,000
Posts and railroad ties	number..	337,500
General merchandise and provisions	pounds..	1,901,000

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

The increased harbor facilities have had a favorable effect upon rates of freight and transportation, while rates of marine insurance have probably not been very materially changed.

The improvement of this harbor has tended to increase commerce beyond the natural growth of the town, as a comparison with other places of about equal size where there are no harbor improvements would show.

There are no competing routes of transportation.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

The commerce of this port has increased very considerably since the commencement of the work here, as the accompanying statistics show, and benefits have accrued both to the general commerce of the lakes and to local interests which the completion of the proposed improvement would increase.

G G 15.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers for 1881, page 2084)	$200,000.00
Appropriated by the United States	45,000.00
Appropriated by local authorities	8,042.72
Total	53,042.72

A survey of this harbor was ordered by act of Congress approved June 14, 1880, and the first appropriation was made March 3, 1881.

The project of improvement consists in the formation of a channel from a point about 2,000 feet south of the mouth of Kewaunee River, through a spit about 300 feet wide, affording communication between the river and Lake Michigan. From the lake end of this cut two parallel pile-piers are to be constructed, extending to the 18-foot curve, with dredging between and through the cut to a depth of 14 feet.

Under the appropriation of $10,000, approved August 5, 1886, a contract, dated October 19, 1886, was entered into with Messrs. Schwarz & Berner, of Green Bay, Wis., for building 300 linear feet of pile-pier. Work under this contract commenced May 18, 1887, and up to June 30, 1887, 100 linear feet have been completed and 150 linear feet is well under way.

By hired labor and purchase in open market additional stone filling was deposited in sections 10 to 14 of the north pier and 6 to 15 of the south pier, about 200 cords being used for this purpose.

Nine thousand and thirty-five cubic yards of material were also removed from the harbor by the United States dredges.

The south pier is 775 feet in length, and the north pier, when the present contract is completed, will be 1,000 feet long, being 54 per cent. of the approved project.

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One hundred and twenty-six thousand and eleven cubic yards of material, or 63 per cent. of the total required, have been removed by dredging.

There is 9 feet depth of water at the entrance, the channel between the piers being about 100 feet wide with a depth of from 10 to 12 feet. The old river bed north of the new entrance also has been dredged, forming a basin 475 feet long, 150 feet wide, and 10 feet deep.

It is doubtful if the local business at this harbor would in itself justify the completion of the improvement. It will, however, afford protection for vessels in stress of weather, and as a harbor of refuge its completion is desirable.

Should an appropriation be made for the fiscal year ending June 30, 1889, it is contemplated to expend it in further pier construction, dredging, and repairs to the present piers, if necessary.

Length of north pier, June 30, 1887	feet..	800
Length of south pier, June 30, 1887	do...	775
Number of cubic yards dredged to June 30, 1887		126,011

Money statement.

July 1, 1886, amount available	$63.33
Amount appropriated by act approved August 5, 1886	10,000.00
	10,063.33
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,404.49
July 1, 1887, amount available	7,658.84
Amount (estimated) required for completion of existing project	146,957.28
Amount that can be profitably expended in fiscal year ending June 30, 1889	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals received and opened, September 24, 1886, for extension of piers at Kewaunee Harbor, Wisconsin.

Articles.	1. John Wrabetz, Kewaunee, Wis.	2. Truman & Cooper, Manitowoc, Wis.	3. Schwarz & Berner, Green Bay, Wis.*	4. Knapp & Gillen, Racine, Wis.	5. William T. Casgrain Milwaukee, Wis.
Round piles, 11,400 linear feet.....per linear foot..	$0.20	$0.20	$0.18	$0.18	$0.23
White oak timber (10 by 12 inches and 6 by 12 inches), 20,100 feet, B. M .....per M, B. M..	42.65	50.00	48.00	45.00	45.00
Pine timber (12 by 12 inches), 560 linear feet, per linear foot	.25	.27	.24	.23	.32
Pine timber (6 by 12 inches), 700 linear feet, per linear foot	.38	.14	.15	.13	.18
Sheet pile (pine plank, 3 by 12 inches), 48,000 feet, per M, B. M	37.00	30.00	28.00	25.50	35.00
Pine plank (3 by 12 inches), 1,500 feet, per M, B. M	25.00	18.00	14.00	16.00	25.00
Stone, 450 cords .....per cord..	4.25	6.00	4.95	5.25	5.90
Wrought iron screw-bolts and tie-rods, 8,250 pounds.....per pound..	.10	.06	.04½	.06	.06
Wrought iron spikes, 550 pounds .....do....	.10	.05	.04½	.04	.06
Total	8,149.26	8,223.70	7,265.32	7,303.80	8,732.20

*Accepted.

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COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Twin River Point, Wisconsin.

(1) Amount expended to June 30, 1887 ..... $37,341.16
Amount required to complete improvement 146,957.28
Annual cost of preserving and maintaining 6,400.00

(2) Amount of commerce and navigation when work of improvement began in 1881:

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1881.

Vessels arrived and departed: Number, 267; tonnage, 90,175.

Principal articles of import:	Approximate value.
Apples, beer, salt, and coal	$5,450
Pork, oil, corn, land plaster, etc	9,500
Dry goods, groceries, hardware, machinery, etc	115,000
Total	129,950

Principal articles of export:	
Lumber, bark, railroad ties, shingles, and wood	90,300
Butter, cheese, eggs, potatoes, etc	8,200
Hides, tallow, and wool	4,100
Grain	115,900
Flour	20,000
Total	238,500

(3) Amount of commerce and navigation at the present time:

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Vessels arrived and departed: Number, 350; tonnage, 95,000.

Principal articles of import:	Approximate value.
Apples, fruit, beer, and coal	$7,000
Pork, oil, corn, and land plaster	9,000
Dry goods, groceries, hardware, and machinery	125,000
Total	141,000

Principal articles of export:	
Railroad ties, bark, shingles, and wood	80,000
Butter, cheese, eggs, and poultry	15,000
Hides, tallow, and wool	10,000
Wheat, peas, oats, rye, and beans	125,000
Flour, feed, and bran	35,000
Total	265,000

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation:

The increased harbor facilities, enabling boats to enter and to load and unload from inside docks, have had the effect of materially reducing freight rates, and this with no competition with railroads.

These same facilities have also, without doubt, tended to reduce the rates of insurance, although to what extent can not be stated.

There are no competing routes of transportation to this port.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement:

A comparison of the statistics does not show any very material increase in the present commerce of this port over that carried on in 1881, the time of commencing the work, and it is doubtful if the local business at this harbor would in itself justify the completion of the improvement. It will, however, afford protection for vessels in stress of weather, and as a harbor of refuge its completion is desirable.

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G G 16.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers, 1871, page 123)	$265,588.80
Appropriated	198,000.00

The project for the improvement of this harbor, adopted in 1870, consists in the construction of two parallel piers extending from the river mouth to the 18-foot contour in Lake Michigan, and dredging between them to a depth of 12 feet. These piers are now, respectively, 1,810 and 1,710 feet long. For a length of about 1,000 feet from the shore-line of 1870 they are composed of piles, and the distance between them is 270 feet. Beyond this they are composed of cribs, the width between which is reduced to 230 feet, gradually increasing to 250 feet at the outer entrance.

During the past fiscal year no work has been done.

It is not deemed necessary to urge an immediate completion of the original project which would require an extension of the north pier of about 400 feet and of the south pier of about 500 feet.

At the close of dredging in September, 1885, the channel was reported to have a depth of 12 feet and a width of about 180 feet.

In May, 1887, it was reported that a narrow channel existed of sufficient depth to admit vessels drawing 10 feet.

The commerce of this harbor has heretofore been merely nominal, nearly all the freighting having been done by rail, but since the passage of the interstate commerce law efforts have been made to get the Goodrich Transportation line of steamers to run to this port, therefore the work contemplated during the fiscal year ending June 30, 1889, should an appropriation be made, will consist in such dredging as may be necessary to re-establish the 12-foot channel and repairing and refilling the pile-piers.

Length of north pier June 30, 1887	feet	1,810
Length of south pier June 30, 1887	do	1,710
Number of cubic yards removed to June 30, 1887		240,600

Money statement.

July 1, 1886, amount available	$135.33
July 1, 1887, amount available	135.33
Amount (estimated) required for completion of existing project	67,588.80
Amount that can be profitably expended in fiscal year ending June 30, 1889	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1886 and 1867.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Two Rivers, Wis. Collection district, Milwaukee, Wis. Nearest light-house on north pier-head, Two Rivers, Wis.

(1) Amount expended to June 30, 1887	$197,864.67
Amount required to complete improvement	67,588.30
Annual cost of preserving and maintaining	6,900.00

(2) Amount of commerce and navigation when work of improvement began in 1872.

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COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1872.

Arrivals and departures of steamers	474
Arrivals and departures of sailing vessels	141
Value of cargoes shipped	$1,258,318.70
Value of cargoes received	927,000.00

(3) Amount of commerce and navigation at present time.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR 1886.

Vessels arrived and cleared.

	Number.	Tonnage.
Vessels arrived	287	23,840
Vessels cleared	280	22,960

	Approximate value
Principal articles of import:	
Logs and lumber	$700,000
Produce and provisions	475,000
Live stock	40,000
Merchandise	1,650,000
Fish	100,000
Total	2,965,000
Principal articles of export:	
Manufactured articles	2,660,500
Produce and provisions	350,000
Salt and fresh fish	120,000
Merchandise	510,000
Live stock	15,000
Total	3,655,500

(4) The effect, if any of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

The Milwaukee, Lake Shore and Western is the only railroad touching Two Rivers and the only road which would compete with boats. This road was requested to furnish a table of its freight rates to this point, but although promising, has not done so. Without these figures it is impossible to define the effect, if any, of the improvement upon rates for freight by rail. The improvement has, however, cheapened transportation by water.

The question of insurance rates is treated of generally in the letter transmitting this report.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

The commerce of this harbor is merely nominal, nearly all the freighting being done by rail. The improvement has, however, furnished an inside landing-place for what commerce there is, a great advantage over piers extending from the shore into the open lake.

G G 17.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers, 1881, page 2094)	$308,182.54
Appropriated	291,820.00

The existing project of improvement of this harbor consists in the construction of two parallel crib-piers, 250 feet apart, extending from the mouth of the Manitowoc River to the 18½-foot contour in Lake Michigan,

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and dredging a channel 14 feet deep between the inner ends of the piers, increasing to 18 feet depth at the outer entrance.

The first appropriation for the improvement of this harbor was made in 1852, the system of improvement adopted at that time, though modified in some respects since, being substantially the same as that now in progress.

Under the appropriation of $15,000 approved August 5, 1886, a contract, dated October 19, 1886, was entered into with Messrs. Truman & Cooper, of Manitowoc, Wis., for the construction of five cribs, each 50 by 24 by 16½ feet in height and full or partial superstructure upon the same, the height of the superstructure depending upon the prices bid. It is probable that available funds will permit completing the superstructure.

Work under this contract commenced May 11, and up to June 30 four cribs have been sunk in extension of the south pier. The terms of the contract require that at least forty-five days shall intervene between the sinking of the last crib and the commencement of the superstructure.

The north pier is completed, and the cribs sunk under the present contract will complete the south pier.

The channel is in good condition, there being 18 feet depth at the entrance and 14 feet at the shore-line, but periodical dredging will be required to maintain it.

A portion of the superstructure is in bad condition, about 1,600 linear feet being from sixteen to twenty years old. All of this will soon require rebuilding, and, commencing at the shore-end, the south pier should be rebuilt as soon as funds are available.

No additional estimate is deemed necessary at present, as the estimated amount required for the completion of the existing project ($16,362.54) will probably be sufficient.

This is one of the most important harbors on Lake Michigan north of Milwaukee. The ship-yards and machine-shops have diverted considerable trade from Chicago and Milwaukee, the owners of many vessels preferring to have them repaired at Manitowoc than at other lake ports.

There is considerable local commerce and large numbers of vessels seek refuge here during storms.

The appropriation of $16,000 asked for is to be applied to rebuilding a part of the south pier superstructure, and dredging if needed.

Length of north pier June 30, 1887	feet..	1,970
Length of south pier June 30, 1887	do...	1,850
Number of cubic yards dredged to June 30, 1887		156,877

List of materials and labor used at Manitowoc, Wis., in the construction of four cribs each 50 by 24 by 16½ feet.

[Under contract with Truman & Cooper, dated October 19, 1886.]

	Quantities.	Price.	Cost.
Pine timber, 12 by 12 inches and 12 by 18 inches ..... linear feet..	7,116	$0.23	$1,636.68
Hemlock timber, 12 by 12 inches and 12 by 18 inches ..... do....	11,316	.20	2,263.20
Pine plank ..... feet, B. M..	1,920	15.00	28.80
Drift-bolts ..... pounds..	14,763.7	.03	442.91
Screw-bolts ..... do ...	3,800	.04	152.00
Spikes ..... do	93	.04	3.72
Stone ..... cords..	685	6.00	4,110.00
Total			8,637.31

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Money statement.

July 1, 1886, amount available		$801.93
Amount appropriated by act approved August 5, 1886		15,000.00
		15,801.93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$6,287.17	
July 1, 1887, outstanding liabilities	645.76	
		6,932.93
July 1, 1887, amount available		8,869.00
Amount (estimated) required for completion of existing project		16,362.54
Amount that can be profitably expended in fiscal year ending June 30, 1889.		16,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals received and opened September 24, 1886, for extension of piers and construction of superstructure at Manitowoc Harbor, Wis.

Articles.	1. Truman & Cooper, Manitowoc, Wis.*	2. Schnars & Berner, Green Bay, Wis.	3. Knapp & Gillen, Racine, Wis.	4. A. S. Bretherton, Jackson, Mich.†	5. William T. Casgrain, Milwaukee, Wis.	6. Greve & Falge, Manitowoc, Wis.
Pine timber (12 by 12 inches and 12 by 18 inches), 14,500 linear feet, per linear foot	$0.23	$0.28	$0.28	$0.35	$0.37	$0.28
Hemlock timber (12 by 12 inches and 12 by 18 inches), 14,000 linear feet, per linear foot	.20	.25	.25	.35	.35	.18
Pine plank, 19,000 feet, B. M., per M, B. M	15.00	14.00	16.00	15.00	22.00	13.50
Stone, 1,100 cords, per cord	6.00	6.10	6.50	10.00	7.50	7.00
Wrought-iron drift-bolts, 24,400 pounds, per pound	.03	.03½	.04	.04	.03½	.02½
Wrought-iron screw-bolts, 4,800 pounds, per pound	.04	.04½	.05	.05	.06	.03½
Wrought-iron spikes, 1,200 pounds, per pound	.04	.04	.04	.04	.05	.03
Relaying pine plank, 15,000 feet, B. M. per M. B. M	3.00	6.00	6.00	17.00	8.00	14.00
Total	14,037.00	15,744.00	16,368.00	22,779.00	20,265.00	15,548.50

* Accepted. † Informal. No guaranty accompanying bid.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Manitowoc, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Manitowoc, Wis.

(1) Amount expended to June 30, 1887		$282,385.74
Amount required to complete improvement		16,362.54
Annual cost of preserving and maintaining		7,700.00

(2) Amount of commerce and navigation when work of improvement began in 1867:

COMMERCIAL STATISTICS FOR THE FISCAL YEAR ENDING JUNE 30, 1867.

Arrivals and departures of vessels.

	Number.	Tonnage.
Arrivals of vessels	685	149,894
Departures of vessels	689	151,590

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Principal articles of export:

Lumber	feet, B. M..	8,912,000
Grain	bushels..	80,662
Shingles, lath, pickets, etc	number..	61,219,400
Flour	barrels..	2,160

(3) Amount of commerce and navigation at present time:

COMMERCIAL STATISTICS FOR CALENDAR YEAR 1886.

Arrivals and departures of vessels.

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	342	148,785	352	149,522
Sail	214	27,787	221	27,503
Total	556	176,572	573	177,025

Principal articles of export:

Lumber	feet, B. M..	970,000
Grain	bushels..	189,581
Brick	number..	1,592,000
Flour	barrels..	19,216
Butter	pounds..	163,300
General merchandise	packages..	62,495

The above statistics were furnished by the deputy collector of customs for that port.

They are very incomplete, as only the shipments reported at the custom-house are included. The greater part of the business is not so reported. Complete and accurate figures, if obtainable, would, it is believed, show an increase in business over previous years.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon rates of competing routes of transportation:

The Milwaukee, Lake Shore and Western is the only railroad touching Manitowoc, and the only competitor with boats for Manitowoc business. This road was requested several times to furnish a table of its freight rates, past and present, and promised to do so, but as yet has not. The effect, if any, which the improvement of this harbor may have had upon the rates of freight by rail can not, therefore, be accurately determined. The improvement has, however, materially lessened the cost of transportation by water, and must, it would seem, have had a corresponding effect upon charges by rail.

The question of the effect of this improvement upon rates of insurance is treated of generally in the letter transmitting this report.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement:

This is one of the most important harbors on Lake Michigan north of Milwaukee. The ship-yards and machine-shops at Manitowoc have diverted considerable trade from Chicago and Milwaukee, the owners of many vessels prefering to have them repaired at Manitowoc than at other lake ports.

Statistics show a gradual and material increase in the commerce of this port since the work of improvement began. The harbor has been, without doubt, of benefit to general and local commerce, and the prospective advantages to commerce and to the community would seem to justify a completion of the proposed improvement.

G G 18.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers, 1881, page 2104)	$150,000
Additional estimate (Annual Report of Chief of Engineers, 1884, page 1856)	45,000
Total	195,000
Appropriated	98,000

The improvement consists in the construction of two piers about 275 feet apart at the outer ends, extending from the mouth of the Sheboy-

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gan River to the 20-foot contour in Lake Michigan, with a dredged channel between 18 feet deep at the entrance of the piers and gradually reducing to 14 feet at the shore-line, connecting the deep water of the lake with that of the river.

Under the appropriation of $15,000 approved August 5, 1886, a contract, dated October 19, 1886, was entered into with Messrs. Truman & Cooper, of Manitowoc, Wis., for building and sinking on a pile foundation four cribs each 50 feet long and 20 feet wide, and covering them with superstructure. Including the superstructure the cribs will be 18½ feet in height, and will extend the north pier 200 feet. It is expected that work under this contract will commence early in July, 1887. The contract is to be completed by October 31, 1887.

The operations during the fiscal year have consisted in dredging by hired labor with a dredge belonging to the United States. Commencing June 13, up to June 30, 10,075 cubic yards had been removed. Dredging will be continued until about July 15, at which date available funds for that purpose will be exhausted.

As stated in previous reports, this dredging affords but temporary relief, as, owing to the open character of the old crib-pier, large quantities of sand pass through the piers and are deposited as a bar near the entrance. This bar has been a great impediment to commerce, and it is thought that no permanent improvement can be obtained until the piers have been extended over the bar into deep water. It may also be necessary to render the older portion of the piers sand-tight by means of some kind of revetment. In view of the above facts, a sufficient amount of money should be made available to permit the rapid extension of the piers.

The local commerce is large, and this harbor would be extensively sought for shelter if the depth was sufficient for vessels to enter safely.

To complete the project, after the present contract is finished, 750 linear feet of crib-piers remain to be built, and about 69,000 cubic yards of material to be removed by dredging.

The condition of the shore-end of the south pier is such that it must be extensively repaired or entirely rebuilt in the near future. For 150 feet outside the present shore-line, and for about the same distance inside, the superstructure is badly rotted and burned away, so that sand is driven through into the channel to such an extent that the shore-line has slightly receded, though in the forty years preceding 1879 it had advanced over 300 feet.

There is some doubt as to the responsibility for the care of this part of the work. It was occupied for several years by the Sheboygan and Fond du Lac Railroad Company as a wharf-front; their warehouse and dock burned down a few years ago, and have not been rebuilt. It is probable that the needed repairs must be made by the United States, if they are made at all.

With the appropriation asked for the fiscal year ending June 30, 1889, it is proposed to continue the pier extension and dredging, also to make some repairs to the piers.

Length of the north pier June 30, 1887	feet..	1,884
Length of the south pier June 30, 1887	do...	2,260
Number of cubic yards dredged to June 30, 1887		182,633

About 72 per cent. of the dredging is completed, and 84.3 per cent. of the pier construction will be completed when present contract is finished.

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Money statement.

July 1, 1886, amount available	$2.22
Amount appropriated by act approved August 5, 1886	15,000.00
	15,002.22
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,480.43
July 1, 1887, amount available	13,521.79
Amount (estimated) required for completion of existing project	97,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals received and opened September 24, 1886, for extension of piers and construction of superstructure at Sheboygan Harbor, Wisconsin.

Articles.	1. Knapp & Gillen. Racine, Wis.	2. Schwarz & Berner, Green Bay, Wis.	3. Truman & Cooper, Manitowoc, Wis.*	4. A. S. Bretherton, Jackson, Mich.†	5. Wm. T. Casgrain, Milwaukee, Wis.
Pine timber, 12 by 12 inches and 12 by 18 inches, 9,500 linear feet...per linear foot	$0.28	$0.28	$0.27	$0.35	$0.35
Hemlock timber, 12 by 12 inches and 12 by 18 inches, 9,700 linear feet, per lin. ft	.25	.26	.23	.35	.35
Pine plank, 11,000 feet, B. M., per M	16.00	16.00	15.00	15.00	25.00
Stone, 680 cords.....per cord	7.00	7.25	6.50	12.00	8.00
Wrought-iron drift-bolts, 15,500 pounds ...per pound	.04	.03½	.03	.04	.04
Wrought-iron screw-bolts, 4,000 pounds.... per pound	.06	.04½	.04	.05	.06
Wrought-iron spikes, 440 pounds .....per pound	.04	.04	.04	.04	.05
Piles, 96.....each	12.00	9.00	8.00	12.00	12.00
Total	12,050.60	11,892.10	10,791.60	17,034.60	14,469.00

* Accepted. † Informal. No guaranty accompanying bid.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Sheboygan, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Sheboygan, Wis.

(1) Amount expended to June 30, 1887	$274,927.12
Amount required to complete improvement	97,000.00
Annual cost of preserving and maintaining	9,500.00

(2) Amount of commerce and navigation when work of improvement began in 1867.

During the fiscal year ending June 30, 1867, there cleared from this port 1,114 vessels.

The principal articles of import and export during the year are given below.

IMPORTS.

Lumber	feet, B. M.	413,000
Iron	bundles	7,315
Grain	bushels	16,934
General merchandise, etc	packages	45,965

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EXPORTS.

Flour	barrels..	24,223
Grain	bushels..	173,769
Laths	number..	1,065,000
Butter and cheese	pounds..	163,800
Miscellaneous	packages..	60,821

(3) Amount of commerce and navigation at present time.

STATISTICS OF COMMERCE FOR THE CALENDAR YEAR 1886.

Arrivals and departures of vessels.

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	456	301,189	456	300,628
Sail	585	52,333	600	54,296
Total	1,041	353,522	1,056	354,924

The approximate value of the principal articles of export is $4,900,000, and of the principal articles of import $3,900,000.

(4) The effect, if any, of work thus far executed upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

The Milwaukee, Lake Shore and Western Railroad is the only road reaching Sheboygan and competing with vessels for the Sheboygan business. The effect of the improvement upon the freight rates of this road can not be stated, the company not furnishing, as requested, a table of its charges. There can be no doubt, however, that the competition created by the improvement has caused a reduction in cost of transportation. The improvement has also tended to reduce rates of insurance by lessening the dangers of navigation.

(5) Prospective advantages to commerce as well as benefits to the community by the completion of the proposed improvement.

A comparison of the statistics of commerce at this port from year to year since the improvement began shows a constant and decided increase. Sheboygan is a flourishing and growing place of about 12,000 inhabitants, doing a large business both by rail and water. A continuation and completion of the improvement already so far advanced would sustain and increase this business, conferring benefits upon general commerce and local interests.

G G 19.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

Estimated cost (see Report of Chief of Engineers, 1877, page 866).....	$154,527.17
Additional estimate (Report of Chief of Engineers, 1880, page 1922)...	27,000.00
	181,527.17
Appropriated.....	169,500.00

The present project for the improvement of this harbor was adopted in 1869, and modified in 1870 and 1876, the object being to form by dredging two interior basins, with a combined area of about 5¾ acres and a depth of 12 feet, with a channel of the same depth connecting these basins with the lake.

The natural channel at the mouth of the Sauk River was narrow and at the shoalest point had a depth of but 1 foot.

The channel entrance, north of the mouth of the Sauk River, is inclosed between two parallel piers about 150 feet apart, extending from the shore-line to the 14-foot contour in Lake Michigan, so constructed that the flow of the river is separated from the channel and the débris brought down by freshets, instead of shoaling the channel, re-enforces the south pier.

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Under the appropriation of $5,000, approved August 5, 1886, a contract, dated October 19, 1886, was entered into with Messrs. Truman & Cooper, of Manitowoc, Wis., for building and sinking in place one crib 50 by 24 by 12½ feet, and the construction of superstructure upon the same. The crib was sunk in extension of the north pier in November, and the superstructure will probably be completed in July.

No further extension of the north pier is contemplated, and when the superstructure is finished the pier will be in readiness to receive a pier-head light.

To complete the project the south pier should be extended 100 feet, and about 42,000 cubic yards of material removed by dredging.

Cribs Nos. 8 and 9 of the north pier require additional stone filling and planking.

The approved project contemplated the construction of a small harbor for local purposes, and when completed it will meet the present and prospective demands of commerce.

The piers are short and the character of the lake bottom hard, therefore the probable cost of maintenance is small.

Eighty-five and three-fourths per cent. of the dredging is completed, and when the present contract is closed 95.5 per cent. of the pier construction will be completed.

With the money asked for for the fiscal year ending June 30, 1889, it is proposed to complete the project by pier construction and dredging.

Length of north pier June 30, 1887	feet	920
Length of south pier June 30, 1887	do	1,226
Number of cubic yards removed to June 30, 1887		253,204

Money statement.

July 1, 1886, amount available		$10.61
Received from sale of fuel to officer		16.50
Amount appropriated by act approved August 5, 1886		5,000.00
		5,027.11
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,591.84	
July 1, 1887, outstanding liabilities	218.74	
		2,810.58
July 1, 1887, amount available		2,216.53
Amount (estimated) required for completion of existing project		12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		12,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

List of materials and labor used at Port Washington Harbor, Wisconsin, in building one crib 50 feet by 24 feet by 12½ feet for extension of the north pier.

[Under contract with Truman & Cooper, dated October 19, 1886.]

Articles.	Quantities.	Price.	Cost.
Pine timber 12 by 12 inches and 12 by 18 inches, linear feet	3,460	$0.30	$1,038.00
Hemlock timber 12 by 12 inches, do	96	.24	23.04
Pine plank, feet B. M.	2,880	16.00	46.08
Drift-bolts, pounds	2,719	.03	81.57
Screw-bolts, do	793	.04	31.72
Spikes, do	125	.04	5.00
Stone, cords	137.44	7.00	962.08
Total			2,187.49

Cost of crib per linear foot	$43.75
Cost of crib per cubic foot	.14583

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Abstract of proposals received and opened September 24, 1886, for extension of piers and construction of superstructure at Port Washington Harbor, Wisconsin.

Articles.	1. Knapp & Gillen, Racine, Wis.	2. Truman & Cooper, Manitowoc, Wis.*	3. A. S. Bretherton, Jackson, Mich.†	4. William T. Casgrain, Milwaukee, Wis.
Pine timber, 12 by 12 inches and 12 by 18 inches (2,900 linear feet)....per linear foot..	$0.34	$0.30	$0.35	$0.36½
Hemlock timber, 12 by 12 inches and 12 by 18 inches (2,200 linear feet)....per linear foot..	.31	.24	.35	.35
Pine plank, 3,000 feet B. M.....per M feet, B. M..	18.50	16.00	15.00	20.00
Stone, 170 cords.....per cord..	7.50	7.00	10.00	6.50
Wrought-iron drift-bolts, 4,400 pounds.....per pound..	.04	.03	.04	.04
Wrought-iron screw-bolts, 800 pounds.....do....	.06	.04	.05	.06
Wrought-iron spikes, 250 pounds.....do....	.05	.04	.04	.05
Relaying pine plank, 3,000 feet B. M.....per M feet, B. M..	10.50	5.00	18.00	8.00
Total.....	3,266.50	2,825.00	3,810.00	3,254.00

* Accepted. † Informal; no guaranty accompanying bid.

COMMERCIAL STATISTICS FOR THE YEAR ENDING DECEMBER 31, 1886, AND INFORMATION CALLED FOR BY DEPARTMENT LETTER OF AUGUST 10, 1886.

Name of harbor, Port Washington, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Port Washington, Wis.

(1) Amount expended to June 30, 1887..... $167,081.23
Amount required to complete improvement..... 12,000.00
Annual cost of preserving and maintaining..... 4,700.00

(2) Amount of commerce and navigation when work of improvement began in 1870:

The work of improving this harbor commenced in 1870, at which time all the commerce at the port was carried on from a pier extending into the lake. During the calendar year 1870 the number of vessels arriving and departing was 48, with a tonnage of 3,148 tons. The value of imports during the same period was, approximately, $139,400, and of exports $183,000.

There were no records kept at this port for the year 1870, and there are no means now of ascertaining exactly the amount of commerce done. The above information was furnished by Mr. R. C. Kann, of Port Washington, compiled from such data as he was able to secure, and is believed to be approximately correct.

(3) Amount of commerce and navigation at present time:

The arrivals and departures of vessels during the calendar year 1886 were 286, with a tonnage of 18,989 tons. The commerce is shown by the following statistics, also furnished by Mr. R. C. Kann:

Principal articles of import:

	Approximate value.
Lumber, lath, and shingles	$110,000
Pig-iron and coal	140,000
Hides	108,000
Barley	170,000
Tan-bark	12,000
General merchandise	185,000
Total	725,000

Principal articles of export:

Leather	162,000
Barley and malt	186,000
Lime	145,000

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	Approximate value.
Principal articles of export—Continued.	
Wheat and hay	$118,000
Flour	850,000
Butter, eggs, and cheese	182,000
Total	1,643,000

(4) The effect, if any, of work thus far executed upon rates of freight and insurance, and also upon the rates of competing routes of transportation:

There are no competing routes to this point, and the question of freight and insurance rates is treated of in the letter transmitting this report.

(5) Prospective advantages to commerce, as well as benefits to the community, by the completion of the proposed improvement:

It is doubtful if the commerce at this port will increase beyond its present dimensions; still it is believed that a completion of the project now so nearly finished will, in giving greater permanency and security to the work, add to the safety and availability of the harbor, thus benefiting general and local commerce.

G G 20.

PRELIMINARY EXAMINATION OF TORCH LAKE CHANNEL, LAKE SUPERIOR, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Milwaukee Wis., November 15, 1886.

SIR: I have the honor to report that, in compliance with your instructions of October 28, 1886, an examination was made by me during the present month of Torch Lake Channel, Lake Superior, Michigan, as called for by the provisions of the river and harbor act of August 5, 1886.

Torch Lake is 5¾ miles long and 1¾ miles in its widest part, with a maximum depth of 155 feet. Its longer axis lies approximately northeast and southwest, and the lake itself was connected with Torch Bay, an arm of Portage Lake, by a narrow, circuitous channel of 6 and 7 feet of water, with a bar at its Torch Lake end with but 3 feet of water on it.

About twenty years ago the Calumet and Hecla Mining Company, which has a stamp-mill on Torch Lake, built a landing dock in Torch Lake Channel for landing coal and supplies from the regular lake steamers, from which dock it was removed by tugs and lighters. At this time the company also did some dredging, but only to facilitate navigation for lighters.

Seven years later it was decided to deepen the channel to steamer depth. For this purpose a cut was made 60 feet wide and 13½ feet deep, or the same depth as is available through the Portage Lake Ship-Canal.

This cut, 2½ miles long, does not follow the natural channel, but a rectified line, some portions of which were cut through solid land. The total cost of these improvements somewhat exceeded $100,000, and the work was done under a charter from the State of Michigan.

Up to the present year no tolls have been charged, but this year a rate has been established, and a copy* of this rate is inclosed herewith.

Two other mining companies, the Osceola and Tamarack, have stamp-mills on Torch Lake, and if the Government should undertake the pur-

*Omitted.

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chase and improvement of Torch Lake Channel, would be exempt from tolls, while the canal company itself would be freed from cost of maintenance; but the commerce of the lake, although very large, is, after all, entirely local, and in my opinion this improvement does not come within the intent of the river and harbor act of "subserving public necessity or convenience."

I therefore respectfully recommend that no work be done at this place by the United States Government.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX H H.

CONSTRUCTION OF HARBOR OF REFUGE, MILWAUKEE BAY—IMPROVEMENT OF THE HARBORS OF MILWAUKEE, RACINE, KENOSHA, AND WAUKEGAN—IMPROVEMENT OF FOX AND WISCONSIN RIVERS.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor of Refuge, Milwaukee Bay, Wisconsin.
2. Milwaukee Harbor, Wisconsin.
3. Racine Harbor, Wisconsin.
4. Kenosha Harbor, Wisconsin.
5. Waukegan Harbor, Illinois.
6. Fox and Wisconsin rivers, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., August 6, 1887.

SIR: I have the honor to transmit herewith annual reports for the works in my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

H H 1.

HARBOR OF REFUGE AT MILWAUKEE BAY, WISCONSIN.

CONDITION OF WORK JUNE 30, 1887.

At the close of the fiscal year ending June 30, 1886, the breakwater had been extended 3,100 feet, over 650 linear feet of which superstructure had not been built.

Under the river and harbor act approved August 5, 1886, proposals were solicited and received for continuing the work under formal contract, and opened at Milwaukee, Wis., September 14, 1886.

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The following is the abstract of proposals received:

TIMBER CRIB BREAKWATER ON STONE FOUNDATION.

Abstract of proposals for construction of breakwater, harbor of refuge, Milwaukee Bay, Wis., received in response to advertisement dated August 27, 1886, and opened September 14, 1886, by Capt. W. L. Marshall, Corps of Engineers.

Articles.	1. W. T. Casgrain, Milwaukee, Wis.	2. Horatio Truman and George Cooper, Manitowoc, Wis.	3. Hiero B. Herr & Co., Chicago, Ill.	4. Christopher H. Starke, Milwaukee, Wis.	5. F. M. Knapp and E. Gilkin, Racine, Wis.	6. Christian Schwarz and Charles Berner, Fort Howard, Wis.
Pine timber (727,780 feet, B. M.) .per M.	$19.30	$19.50	$15.00	$18.00	$19.25	$17.00
Pine plank (27,000 feet, B. M.) .....do..	16.70	16.50	13.00	16.00	16.50	12.00
Iron drift-bolts (81,200 pounds)...per lb.	.04	.04	.04	.03	.04	.03½
Iron screw-bolts, nuts, and washers (1,170 pounds).....per pound.	.06	.06	.05	.06	.06	.05
Iron spikes, 8-inch (4,650 pounds) .per lb.	.05	.05	.05	.04	.05	.04
Stone (3,900 cords) .....per cord.	9.80	9.20	7.50	8.00	9.25	8.00
Framing (727,780 feet, B. M.)....per M	9.00	9.50	8.00	9.00	9.50	7.75
Laying plank (27,000 feet, B. M.) ...do..	7.00	7.00	6.00	5.00	6.00	3.00
Taking up plank .....do..	10.00	8.00	7.00	6.00	10.25	3.00
Total cost of 350 feet substructure and 650 feet of superstructure..	63,007.13	61,171.18	50,041.24	54,109.62	61,157.23	52,704.35

With approval of the Chief of Engineers, a contract was entered into September 29, 1886, with Hiero B. Herr & Co., the lowest responsible bidders for the work, who, under their contract during the fiscal year ending June 30, 1887, placed five cribs on stone foundation, three of which were in replacement of the three cribs overturned by ice pressure during the storm of March 23, 1887, extending the east arm of the breakwater 100 feet to the southward, and completed superstructure over 250 feet of substructure previously constructed.

The length of the breakwater at the close of the fiscal year ending June 30, 1887, is 3,200 feet, over 2,700 feet of which superstructure has been completed.

There remains to be constructed of the breakwater 4,050 linear feet, including superstructure, and superstructure over 500 feet of substructure already constructed.

On the night of March 23, 1887, a violent easterly storm impelled a field of ice, which had been previously driven from the shore by westerly winds, against the breakwater, and three of the cribs at the south end of the incomplete work yielded to the pressure and were overturned, and still lie near their former site.

Had the superstructure, which is continuous, been completed, or had the wind been oblique, or the harbor been filled with ice, the accident would not probably have occurred, whatever may have been the violence of the storm.

To increase the stability of the work, the plan for the future work has been modified, by authority of the Chief of Engineers, as follows:

The length of the cribs are to be 100 feet instead of 50 feet; the berme of the stone foundation to be widened on the land side, and the breakwater to be backed up with stone on this side about 6 feet.

These modifications will increase the cost of the substructure about $8 per linear foot, or 6 per cent. This increases the original estimate

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made for the work for the part still to be built $33,600, which is included in the estimate herewith.

Careful account of the cost of the work, exclusive of engineering and superintendence and office expenses, has been kept, and a tabulated statement will be found with the report hereto appended of Assistant Engineer W. H. Hearding, who has been in local charge of the work since its inception.

The harbor is becoming available, to a limited extent, as a harbor of refuge during northerly storms, and a point is now reached in its development when its sheltered area is more rapidly extended than heretofore as work progresses.

The last appropriation for this work combined the harbor of refuge, Milwaukee Bay, and Milwaukee Harbor. Of the amount appropriated an allotment sufficient, with the balance remaining on hand from former appropriations for Milwaukee Harbor, to rebuild the superstructure over the outer section of the north pier of Milwaukee Harbor, has been made by the War Department.

The necessary amount is estimated at approximately $4,000, which should be deducted from the amount stated in the financial statement below as "amount available." It is not available for the harbor of refuge, having been allotted under the act of August 5, 1886, to Milwaukee Harbor. It should be deducted also from the statement of the amount appropriated for the work.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURES DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

All funds now available will be required for the continuance of the work under the present contract and for lighting the breakwater during the present season of navigation. Any further appropriations that may be made applicable to the work during the fiscal year will be expended in extending the east arm of the breakwater southward.

PROPOSED APPLICATION OF FUNDS ASKED FOR FISCAL YEAR ENDING JUNE 30, 1889.

The funds asked for are to be used to extend the main arm of the breakwater southward and to complete the superstructure over the work as far as it will then have been built.

It is hoped that the next appropriation may be of sufficient magnitude to allow the work to be advanced far enough to meet to an appreciable extent the needs of navigation for a harbor of refuge.

This harbor is of use to the general commerce of the lakes, including that between Lake Michigan ports and the other great lakes.

A statement of the amount of commerce, which is increasing, may be found in Colonel Houston's report, published in House Ex. Doc. No. 43, Forty-sixth Congress, third session.

Money statement.

July 1, 1886, amount available		$1,738.62
Amount appropriated by act approved August 5, 1886		60,000.00
		61,738.62
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$20,072.72	
July 1, 1887, outstanding liabilities	1,911.32	
		21,984.04
July 1, 1887, amount available		39,754.58

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Amount (estimated) required for completion of existing project.....$488,606.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1887.

SIR: The following report upon the breakwater for harbor of refuge, Milwaukee Bay, Wisconsin, for the fiscal year ending this date, is respectfully submitted.

By act of Congress of August 5, 1886, the sum of $60,000 was appropriated for the extension of the "breakwater for harbor of refuge, Milwaukee Bay, and improvement of Milwaukee Harbor."

On the 27th day of the same month advertisements were inserted in the daily papers inviting proposals for the construction of seven cribs, each of which to be of dimensions 50 feet by 24 feet by 22½ feet; to be built and placed upon stone foundations in extension of the breakwater, and also for the construction of 650 running feet of superstructure upon cribs already sunk in place.

Bids were received until noon September 14, 1886, at which time they were opened, and the work was awarded to the lowest bidders, Messrs. Hiero B. Herr & Co., of Chicago, Ill. A contract was entered into by them for doing the work on the 29th day of the same month. Work upon the superstructure was commenced by the contractors in October, and continued until the 2d day of December, when operations were suspended by reason of the severity of the weather.

Several heavy storms occurred during the winter, and on the night of the 23d of March three of the cribs (Nos. 54, 55, and 56) were removed from their positions at the southern extremity of the breakwater by an easterly storm of unusual violence. At the time of this occurrence the condition of the lake was such as to produce a most destructive effect. The ice-floes, which for a day or two previous had been driven from the shore into the lake by westerly winds, were returned by the heavy easterly gale with such force upon the breakwater as to overturn the three cribs and carry them entirely off the line of the work, leaving them on their inner or western sides. These cribs were sunk in June and July, 1885, and previous to their removal had withstood the force of many heavy seas without being affected thereby either in alignment or horizontality.

The foundations of the cribs were but slightly disturbed, their displacement having been effected by the force of the ice, applied near the water-line, which overturned them upon their inner lower edges. The cribs were placed, in accordance with the specified plan, upon a stone foundation, the top of which was laid at a depth of 20 feet below datum.

After the cribs were removed I took soundings over their former sites, and in two or three places found depths of less than 16 feet of water. These reduced depths were undoubtedly due to the running out of the stone through the grillage at the instant of the overturning of the cribs. The general depths ranged from 18.5 to 21.6 feet. The mean distances to which the cribs were forced to the westward of the western line of breakwater were as follows:

	Feet.
Crib No. 54	24.4
Crib No. 55	31
Crib No. 56	15

If the cribs had been provided with superstructure it is possible that they might have withstood the force applied by the ice. In supplying new cribs to take the places of those removed it was considered advisable not to disturb the foundations of stone already laid and compacted by time and pressure, but to build them of such a height as to conform with the height of the solidified foundations, so that superstructure might be built over them as soon as desired, without fear of further serious settlement. Three cribs, Nos. 54, 55, and 56, were therefore constructed of dimensions 50 feet in length by 24 in width and 18½ feet in height, instead of 22½ feet as has been necessary for foundations laid at 20 feet below datum. These have been successfully sunk by the contractors, as have also Cribs Nos. 57 and 58, of the specified dimensions, 50 by 24 by 22½ feet.

The remaining cribs, 59 and 60, to be built under the present contract, are well advanced, and will be sunk during the month of July, and work upon the superstructure will be resumed.

The anchorage area behind the breakwater will now accommodate a number of vessels seeking shelter from northeast storms. The schooner-rigged scow *L. May*

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Guthrie was used as a light-ship at the south end of the breakwater until the close of navigation in 1886, and the scow *Dunham* has been used for the same purpose since May 1, 1887, under an agreement made with the lowest bidder for keeping a light, in accordance with specifications. The services of the *Dunham* will be employed until the close of navigation in 1887.

The following table exhibits the cost of each crib in the breakwater from Crib No. 1 to Crib 53:

[Cribs 1 to 26 built under contract of J. W. Dennis, of date June 20, 1881. Cribs 27 to 43 built under contract of C. H. Starke, of date October 11, 1883. Cribs 44 to 53 built under contract of C. H. Starke, of date September 12, 1884.]

Number of crib.	Depth of water in which placed.	Dimensions of crib.	Cost of crib.	Height of foundation.	Cost of foundation.	Cost of superstructure.	Total cost with superstructure.
	Feet.	*Feet.*		*Feet.*	*Feet.*		
1	8.4	100 x 20 x 10½	$2,611.62	(*)	(†)	$742.99	$3,354.61
2	9.3	100 x 20 x 10½	2,611.62	(*)	(†)	742.99	3,354.61
3	9.6	100 x 20 x 10½	2,673.34	(*)	(†)	742.99	3,416.33
4	9.8	100 x 20 x 12½	3,107.59	(*)	(†)	742.99	3,850.58
5	11.0	100 x 20 x 12½	3,180.00	(*)	(†)	742.99	3,922.99
6	12.5	100 x 20 x 14½	3,697.50	(*)	(†)	742.99	4,440.49
7	13.5	50 x 24 x 14½	2,118.19	(*)	(†)	612.63	2,730.82
8	14.1	50 x 24 x 16½	2,391.49	(*)	(†)	612.63	3,004.12
9	14.5	50 x 24 x 16½	2,392.78	(*)	(†)	612.63	3,005.41
10	15.1	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
11	15.5	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
12	16.0	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
13	16.3	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
14	16.8	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
15	18.2	50 x 24 x 18½	2,674.45	(*)	(†)	612.63	3,287.08
16	18.8	50 x 24 x 18½	2,674.45	(*)	(†)	819.29	3,493.74
17	19.0	50 x 24 x 20½	2,959.15	(*)	(†)	819.29	3,778.44
18	19.3	50 x 24 x 22½	3,241.19	(*)	(†)	819.29	4,060.48
19	19.9	50 x 24 x 22½	3,241.19	(*)	(†)	819.29	4,060.48
20	20.4	50 x 24 x 22½	3,241.19	(*)	(†)	819.29	4,060.48
21	20.6	50 x 24 x 22½	3,241.19	(*)	(†)	819.29	4,060.48
22	20.8	50 x 24 x 22½	3,265.02	(*)	(†)	819.29	4,084.31
23	21.2	50 x 24 x 24½	3,522.64	(*)	(†)	819.29	4,341.93
24	21.6	50 x 24 x 24½	3,523.21	(*)	(†)	819.29	4,342.50
25	21.75	50 x 24 x 24½	3,523.21	(*)	(†)	819.29	4,342.50
26	21.9	50 x 24 x 24½	3,530.02	(*)	(†)	819.29	4,349.31
27	22.8	50 x 24 x 22½	3,764.75	2.0	$710.37	819.29	5,294.41
28	23.4	50 x 24 x 22½	3,764.75	2.5	805.35	819.29	5,389.39
29	24.0	50 x 24 x 20½	3,472.24	6.0	1,048.22	819.29	5,339.75
30	23.8	50 x 24 x 22½	3,798.77	3.8	738.02	625.72	5,162.51
31	24.0	50 x 24 x 22½	3,798.77	4.0	829.13	625.72	5,253.62
32	24.3	50 x 24 x 22½	3,796.84	4.3	917.48	625.72	5,340.04
33	24.5	50 x 24 x 22½	3,796.84	4.5	976.64	625.72	5,399.20
34	24.9	50 x 24 x 22½	3,798.77	4.9	1,032.06	625.72	5,456.55
35	25.2	50 x 24 x 22½	3,787.35	5.2	1,056.78	625.72	5,469.85
36	25.8	50 x 24 x 22½	3,793.06	5.8	1,172.24	625.72	5,591.02
37	26.1	50 x 24 x 22½	3,798.77	6.1	1,191.08	625.72	5,615.57
38	26.5	50 x 24 x 22½	3,798.77	6.5	1,278.23	625.72	5,702.72
39	26.8	50 x 24 x 22½	3,798.77	6.8	1,418.41	625.72	5,842.90
40	27.1	50 x 24 x 22½	3,798.77	7.1	1,476.88	625.72	5,901.37
41	27.2	50 x 24 x 22½	3,690.56	7.2	1,573.12	‡950.27	6,219.95
42	27.6	50 x 24 x 22½	3,659.70	7.6	1,600.27	‡950.27	6,210.24
43	29.4	50 x 24 x 22½	3,659.70	9.4	1,706.50	‡950.27	6,316.47
44	29.4	50 x 24 x 22½	3,041.26	9.4	1,983.24	738.80	5,763.30
45	29.0	50 x 24 x 22½	3,041.26	9.0	1,895.35	738.80	5,675.41
46	29.5	50 x 24 x 22½	3,070.49	9.5	1,902.16	738.80	5,711.45
47	30.2	50 x 24 x 22½	3,070.49	10.2	1,952.32	738.80	5,701.61
48	30.2	50 x 24 x 22½	3,070.48	10.2	1,960.20	738.80	5,769.48
49	30.1	50 x 24 x 22½	3,088.89	10.1	1,982.82	(§)	(§)
50	30.3	50 x 24 x 22½	3,060.60	10.3	2,621.63	(§)	(§)
51	30.6	50 x 24 x 22½	3,060.60	10.6	1,813.98	(§)	(§)
52	30.2	50 x 24 x 22½	3,060.60	10.2	1,912.01	(§)	(§)
53	31.2	50 x 24 x 22½	3,060.60	11.2	2,088.47	(§)	(§)

*On lake bed. †None. ‡8 feet high. §Not yet built.

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The alignment of the cribs has been tested whenever it has been thought necessary. A recent test showed that the storms of last winter had somewhat disturbed two or three of the cribs, and I found it necessary to make a change of about 2 inches in 150 feet in the points governing the direction of the south arm of the breakwater in order to place the cribs sunk under the present contract on the exact line.

The accuracy with which the cribs have been placed on line, and the creditable manner in which the work of construction has been performed, are largely due to the faithful supervision of Mr. Samuel Whitney, United States inspector.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The nearest collection district is Milwaukee, Wis.; the nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry during the last fiscal year is $249,212.89

PLAN FOR PERMANENT SUPERSTRUCTURE OF PIERS FOR LAKE HARBOR WORKS, BY CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., March 7, 1887.

SIR: In my annual report for 1885 I recommended that on account of the advancing price of lumber the superstructures of the harbors in this district should be made permanent. Since that time I have at intervals thought of several plans for permanent structures of stone and concrete, which have been the usual materials proposed, but they are open to the objections of difficulty of construction, great cost, and greater or less wear and destruction by ice and frost. The facing, if of stone, must be of cut stone, carefully laid.

I have now to submit a plan for a permanent superstructure of concrete faced with cast-iron, which is reasonably cheap, and which, it is thought, will obviate some of the objections to exposed concrete blocks, or to expensvie cut stone.

I have to respectfully request that the project submitted may be considered, and that, if it possesses sufficient merit, I may be authorized to apply it to the extension of the pier of the harbor of refuge, Milwaukee Bay, which, being upon a firm stone foundation, is particularly fitted to receive permanent superstructure.

The drawings, with the explanation of the project written thereon, fully explain the construction.

By the use of cast-iron plates many forms of facing may be employed which may admit secure fastening to the concrete backing. The drawings show only one of such forms, which may perhaps be advantageously modified.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 15, 1887.

Respectfully referred to the Board of Engineers for consideration and for report.

By command of Brigadier-General Duane.

JOHN G. PARKE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

[Second indorsement.]

THE BOARD OF ENGINEERS,
New York, April 12, 1887.

Respectfully returned to the Engineer Department.

The Board of Engineers have considered the method of construction for the superstructure for the breakwater for the harbor of refuge at Milwaukee, proposed by Captain Marshall, Corps of Engineers, and is of opinion that it would be well to construct a piece about 250 feet in length in the most exposed part of the breakwater as an experiment.

For superstructures of greater height and width than that proposed by Captain Marshall the Board is of the opinion that the method recommended by it for the Buffalo Breakwater will be less expensive and quite as durable as the device under consideration; and if the construction at Milwaukee was not to be applied as an experiment would prefer to make the superstructure 14 feet thick on top rather than 10 feet, as suggested.

On behalf of the Board.

THOS. LINCOLN CASEY,
Colonel Corps of Engineers,
President of Board.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 16, 1887.

Respectfully returned to Captain Marshall for his information and guidance, the recommendations of the Board being concurred in by this office.

* * * * * * *

By command of Brigadier-General Duane.

JOHN G. PARKE,
Colonel of Engineers,
Bvt. Maj. Gen., U. S. A.

H H 2.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

CONDITION OF WORK JUNE 30, 1887.

During the fiscal year ending June 30, 1887, work at this harbor has been confined to cutting down and rebuilding superstructure over the outer section of the north pier.

Under the project approved by the Chief of Engineers, for disbursing the balance of the appropriation of August 2, 1882, and the allotment

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from the appropriation of August 5, 1886, proposals were solicited and received for cutting down and rebuilding the superstructure over the north pier outer section, as follows:

Abstract of proposals for cutting down and rebuilding 600 feet of superstructure, north pier, Milwaukee Harbor, Wisconsin, received in response to advertisement dated August 27, 1886, and opened September 14, 1886, by Captain W. L. Marshall, Corps of Engineers.

Articles.	1. W. T. Cosgrain, Milwaukee, Wis.	2. Horatio Truman and George Cooper, Manitowoc, Wis.	3. Hiero B. Herr & Co., Chicago, Ill.	4. Christopher H. Starke, Milwaukee, Wis.
Pine timber, 294,336 feet, B. M.....per M..	$19.00	$19.00	$15.00	$18.00
Iron drift-bolts, 34,400 pounds.....per pound..	.04	.04	.04	.03
Pine plank (3 inch), 12,000 feet, B. M.....per M..	16.50	16.50	11.00	16.00
Iron spikes (8 inch), 800 pounds.....per pound..	.05	.05	.05	.04
White oak piles, in place, 3,500 linear feet...per linear foot..	.40	.45	.30	.32
White oak timber, in place, 9,000 feet, B. M.....per M..	50.00	50.00	45.00	40.00
Iron screw-bolts, 5,000 pounds.....per pound..	.06	.06	.05	.06
Framing timber, 294,336 feet, B. M.....per M..	15.00	16.00	17.00	17.00
Total cost.....	13,771.42	14,240.75	12,707.75	13,337.75

With approval of the Chief of Engineers, a contract was entered into September 29, 1886, with Hiero B. Herr & Co., the lowest responsible bidders for this work, who, during the year, have cut down and rebuilt 270 linear feet of superstructure.

The depth of water through the entrance between the piers has deteriorated to 17 feet, and dredging will be necessary the next season to restore it to its proposed depth of 18 feet at mean low water in Lake Michigan. The width of the 17-foot channel has materially lessened during the past year.

PROPOSED APPLICATION OF FUNDS AVAILABLE AND THOSE ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to apply the funds now on hand from the appropriations of 1882 and 1886 to the completion of the present contract for cutting down and rebuilding the superstructure over the outer section of the north pier.

The funds asked for the fiscal year ending June 30, 1889, are to be applied to the cutting down and rebuilding the superstructure over the outer section of the south pier; to the protection of this work by guard-piles and bulkhead timbers at the ends of the piers; to repairing the pile-protection to the stone superstructure of the inner section of the north pier, and to dredge out the harbor entrance to 18 feet below low water.

This harbor is the second in importance on Lake Michigan. The original project is completed, and it is probable that for many years no work beyond maintenance will be required. The superstructure of the piers when repaired should then, to lessen the cost of maintenance, be made permanent by building it of stone or concrete. The superstructure of the inner section of the north pier of this harbor is now of stone and concrete, and is satisfactory. The cost of stone superstructure is nearly three times that of wood, but it is permanent.

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Money statement.

July 1, 1886, amount available		$8,737.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$801.55	
July 1, 1887, outstanding liabilities	34.40	
		835.95
July 1, 1887, amount available		7,901.95
Amount (estimated) required for completion of existing project		22,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		22,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1887.

SIR: The following report in relation to the harbor of Milwaukee, Wis., is respectfully submitted:

At the commencement of the fiscal year, ending this date, the funds available for the improvement of this harbor were $8,737.90.

The appropriation of $60,000 by act of Congress of date August 5, 1886, for "Improving harbor of refuge at Milwaukee Bay, and Milwaukee River," provided the balance of means necessary to cut down and rebuild the superstructure of the outer section of the north pier, which was built in 1871 and 1872, its length being 600 feet and width 26 feet.

Proposals for doing the work were solicited by advertisement in the daily papers, which proposals were opened on the 14th day of September, 1886.

Messrs. Hiero B. Herr & Co. were the lowest bidders, and a contract was entered into by them for doing the work on the 29th day of the same month.

Owing to the lateness of the season and the necessity of maintaining the beacon light at the extremity of the pier, which is only accessible during storms by means of an elevated platform constructed from the light-house crib to the beacon, it was not considered advisable to commence the work in 1886, with a probability of being obliged to suspend operations before its completion, as such an occurrence would have been a serious inconvenience to the keeping of the light, as well as a possible detriment to navigation. The difficulty experienced by the contractors in obtaining transportation of timber and other causes also retarded operations, so that the work of cutting down was not commenced until the 28th day of last month, since which time the progress made upon the work has not been rapid, owing to the large quantity of stone necessary to be moved from the old work into the new superstructure by means of wheelbarrows.

An equivalent to 270 running feet of new superstructure has been cut down and rebuilt.

On the 6th day of last month I took soundings in the channel between the harbor piers, and submitted a plat of the same. This plat shows the channel, which carries a depth of more than 17 feet of water below datum, to be yet fully 100 feet in width, although the deposit of sand and sewage matter (equal to about six-tenths of a foot during the past year) is gradually narrowing its limits, and it is probable that it will be necessary to enlarge and deepen it by dredging very shortly. The superstructure of the outer section of the south pier needs to be removed, and repairs are necessary at the west ends of both the north and south piers, where they have been damaged by collisions and worn by use and time. The pile protection to the stone superstructure of the inner section of the north pier is also in need of repairs. This necessity is chiefly due to the rough usage to which it is constantly subjected by the mooring of vessels to the wales or fender-timbers which secure the piles in alignment.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

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COMMERCIAL STATISTICS.

The following extract taken from the annual report of the secretary of the Chamber of Commerce for the fiscal year ending April 4, 1887, show the receipts, shipments, and manufactures of some of the leading articles of commerce at the harbor and city of Milwaukee during the year:

Receipts.—Barley, by rail and lake, 6,019,424 bushels—consumed by brewers, 2,446,286 bushels; beer manufactured, 1,203,897 barrels; butter received, 8,288,619 pounds; cheese, 20,023,169 pounds; coal, 759,681 tons, of which 714,242 tons arrived by lake and 45,439 by railroad; corn, 719,230 bushels; eggs, 132,381 packages; flaxseed, 2,298,952 bushels, of which 81,523 bushels were disposed of in this market; flour manufactured in Milwaukee, 952,802 barrels; flour, total receipts, 3,659,377 barrels; fire-wood, 88,365 cords; hides, 612,408; hogs, receipts to February 28, 674,128, of which 553,077 were packed; hops, 13,807 bales; hops used by brewers, 2,078,852 pounds; lumber, 245,555,000 feet, B. M.; shingles, 76,320,000; cedar posts No. 1, 124,328; malt, 3,764,730 bushels; mill stuffs, receipts, 66,500 tons; shipments, 102,293 tons; oats received, 3,074,502 bushels; pig iron, 31,722 tons; potatoes, 604,967 bushels; potatoes shipped, 224,900 bushels; salt, 409,339 barrels; tan bark, 42,596 cords; tallow, 1,512,940 pounds; wheat, 8,527,080 bushels; tobacco (Wisconsin), 11,731,582 pounds; estimated value of product of rolling-mills, $3,750,000; tonnage of material received at rolling-mill, 120,089 tons by lake and 128,384 tons by rail; receipts of office of internal revenue, $2,479,121.92; bank deposits, $598,638,113.21; post-office receipts, $356,327.38; money-order business, $4,595,863.51.

The nearest collection district is Milwaukee, Wis.

The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at this port of entry, $249,212.89.

The arrivals and departures of vessels at this port during the fiscal year, as given by the collector of this port, were as follows:

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	2,570	1,824,089	2,538	1,878,949
Sail vessels	2,743	540,203	2,762	597,234
Total	5,313	2,364,292	5,300	2,476,183

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, December 13, 1886.

SIR: The following information respecting the harbor of Milwaukee, Wis., is respectfully submitted. in accordance with the requirements of circular from the Office of Chief of Engineers, of date August 10, 1886:

(1) The amount expended upon the harbor by the United States Government to November 30, 1886	$276,474.82
Amount expended by the city of Milwaukee	321,355.66
Total	597,830.48

The project is completed. The estimated annual cost of preserving and maintaining harbor is $10,000.

(2) The following notes, taken from the records of the Milwaukee Board of Trade, Chamber of Commerce, exhibit the amount of commerce and navigation when work of improvement began.

"The following aggregate of shipments from this port during the season of 1852 has been taken from the books of those engaged in the business, and may be relied upon as correct:

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Shipments in 1852.

Articles.	Quantity.	Articles.	Quantity.
Flour ..... barrels..	88, 597	Brick ..... number..	700, 000
Wheat ..... bushels..	394, 386	Wool ..... pounds..	321, 121
Barley ..... do....	345, 620	Rags ..... do....	30, 000
Oats ..... do....	428, 811	Salt ..... barrels..	190
Rye ..... do....	67, 759	Ale ..... barrels..	2, 400
Rye flour ..... do ..	124	Whisky ..... do....	712
Corn meal ..... tons..	37	Hides ..... number..	12, 900
Live and dressed hogs ..... pounds..	1, 771, 364	Flax ..... pounds..	4, 211
Pork ..... barrels..	19, 603	Malt ..... bushels..	6, 376
Smoked hams ..... pounds..	102, 314	Flour ..... barrels .	2, 008
Pickled hams ..... barrels..	274	Cattle ..... head..	165
Smoked shoulders ..... do....	85, 972	Horses ..... do....	75
Pickled shoulders ..... do ..	21	Fruit ..... barrels..	270
Lard ..... packages..	1, 226	Broom-corn ..... tons..	227
Tallow ..... barrels..	324	Ashes ..... casks..	3, 291
Beef ham ..... do....	1, 112	Grass seed ..... bushels..	3, 851
Navy beef ..... do....	6, 661	Furs ..... bales..	139
Vinegar ..... do....	887	Lead ..... pounds..	218, 208
Eggs ..... do....	540	Shot ..... do....	31, 150
Butter ..... kegs..	811	Dressed staves ..... number..	167, 000
Beans ..... barrels..	293	Pipe staves ..... do ...	22, 000
Saleratus ..... pounds..	150, 000	Tobacco ..... barrels..	69
Whitefish ..... barrels..	77	Ivory black ..... do....	100
Bran and shorts ..... tons..	300	Merchandise ..... tons..	1, 230
Hops ..... pounds..	11, 625	Merchandise, bulk ..... barrels..	6, 304

Amount of produce in store on March 20, 1853, *to be forwarded.*

Articles.	Quantity.	Articles.	Quantity.
Flour ..... barrels..	45, 220	Beans ..... bushels..	403
Pork ..... do....	15, 821	Grass seed ..... do....	1, 826
Beef ..... do....	269	Malt ..... do....	500
Lard ..... do....	1, 540	Flaxseed ..... do ...	274
Butter ..... pounds..	5, 000	Wool ..... pounds..	7, 311
Wheat ..... bushels..	225, 600	Lead ..... pigs..	150
Rye ..... do....	22, 200	Broom-corn ..... bales..	310
Oats ..... do....	65, 249	Hops ..... do....	20
Barley ..... do....	36, 500	Flax ..... do....	19
Corn ..... do....	70		

"It appears that a larger amount of produce remains to go forward at the opening of navigation at this point than at all others on Lake Michigan combined, or any point on Lake Erie.

"ARRIVALS AND DEPARTURES.

"During the season of navigation in 1852 the number of arrivals, according to the books of the collector, was as follows:

Steamers	841
Propellers	330
Schooners	393
Sloops	1
Brigs	34
Total	1, 599

"Departures about the same as the arrivals.

"LUMBER.

"The lumber trade during the year past has been lighter than for the year 1851, although prices have been a shade better.

"The following are the total receipts for the season of 1852:

Lumber	feet, B. M..	12, 649, 426
Laths		1, 565, 000
Shingles		6, 820, 000
Shingle bolts	cords..	800
Cedar posts		3, 000

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"BEEF AND PORK.

"Wisconsin beef stands as high in the New York market as any produced in this country. Cattle are as good in regard to stock, as well fattened, and as well packed, as the best of that of our neighbors of Illinois. The total amount packed during the season was 10,151 barrels.

"The total number of pork packed during the last season amounts to 23,707 barrels. This generally has brought a high price, and farmers have reaped a rich harvest."

* * *

(3) The quantities of some of the principal items of commerce at present time are copied from the annual report of Milwaukee Chamber of Commerce for 1886, as follows, viz:

RECEIPTS.

Beef cattle	number..	119,964
Sheep	do....	102,314
Hogs (up to March 3)	do....	648,222
Hogs packed (of above)	do....	579,313
Coal by lake	tons..	710,736
Coal by rail	do....	65,014
Total coal	do....	775,750
Lumber	feet, B. M..	238,257,000
Shingles	number..	90,218,000
Paper	pounds..	25,086,285
Butter	do....	10,532,471
Cheese	do....	21,046,462
Tobacco (Wisconsin)	do....	10,557,607
Wool	do....	5,607,141
Wheat	bushels..	9,846,894
Corn	do....	637,065
Mill stuffs	tons..	60,455
Flaxseed	bushels..	2,156,644
Hides	number..	455,993
Hides manufactured into leather (of above)	do....	432,286
Potatoes	bushels..	912,034
Iron ore	tons..	26,704
Flour, manufactured	barrels..	961,152
Total receipts flour	do....	2,232,540
Barley	bushels..	5,392,106
Beer, manufactured	barrels..	1,117,256
Salt	do....	451,923
Rags	pounds..	10,455,364
Hydraulic cement manufactured	barrels..	230,798
Receipts of internal revenue	dollars..	2,477,602.43
Post-office receipts	do....	255,066.07
Money-order business at post-office	do....	4,838,454.54
Bank deposits	do....	559,354,893.00
Revenue from customs	do....	217,110.28

SHIPMENTS OF SOME OF THE LEADING ARTICLES OF COMMERCE.

Wheat	bushels..	5,424,312
Corn	do....	258,265
Oats	do....	619,736
Barley	do....	2,646,902
Rye	do....	188,269
Flour	do....	12,557,200
Through movement	do....	13,610,167
Total local and through		35,304,851
Wool	pounds..	4,533,347
Hides	number..	23,707
Butter	pounds..	7,159,830
Salt	barrels..	385,354
Lumber	feet, B. M..	43,631,500
Coal by rail	tons..	269,277
Cranberries	barrels..	23,500

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Pork, beef, hams, shoulders, and middles	barrels.	50,191
Tierces		17,601
Boxes		73,685
Bulk meats	pounds..	8,807,750
Lard	barrels..	3,293
Tierces		22,099
Mill stuffs, total movement	tons..	91,096
Local consumption of hops	bales..	8,169
Tobacco	pounds..	7,207,303
Butter	do....	7,159,800
Salt	barrels..	385,374

The arrivals and departures at this harbor during the fiscal year ending June 30, 1886, were as follows:

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	2,552	1,877,524	2,536	1,865,841
Sail vessels	2,551	476,317	2,581	485,346
Total	5,103	2,353,841	5,117	2,351,187

The above showing of the number and registered tonnage of vessels for 1886 is not equal to that for some previous years, but subsequent to 1852. This apparent change is partly attributable to the rapid growth and shipping facilities now made available through the improvements made by the Government to the harbor of Duluth, Minn., which improvement has resulted in diverting a large percentage of the wheat grown in the Northwest from its former channel of transit, by way of Milwaukee, to the more direct route east, by way of Duluth.

The reduction in the registration of the tonnage of vessels has also apparently reduced the tonnage of vessels to two-thirds of their former registered capacity. The registered tonnage of eight vessels (selected for comparison) which were afloat in 1860 was then 3,424 tons. Their present register is 2,253 tons.

As to the effects of the improvement of this harbor upon the rates of competing routes of transportation and rates of freight and insurance, the rates of insurance on first-class vessels and steamers, as per annual report of the National Board of Lake Underwriters, have been as follows:

Year.	Class.	Rate.	Year.	Class.	Rate.
		Per cent.			*Per cent.*
1853	Sail vessels	8	1873	Sail	6.5
1855	Steamers	9	1873	Steam	6.5
1860	Sail	7.4	1874	Sail	6.5
1860	Steam	9	1874	Steam	6.5
1865	Sail	8.83	1885	Sail	6.46
1865	Steam	10	1885	Steam	5.6

From 1 to 2 per cent. is added to the general rates of insurance upon vessels where they load from bridge-piers offshore, and where there are no interior harbors. The general reduction in marine insurance on the lakes from 1855 to 1885 is 2 per cent. In 1855 the rates of insurance were from 6.5 per cent. for small vessels to 9 per cent. for large vessels. In 1885 the rates for small vessels were 8¼ per cent., and for large vessels 4¼ per cent., showing that for some reason a great change in rates for the large class of vessels has taken place. This change is probably owing to the increase in the number of harbors and the increased depth of water over the bars in front of their entrance, as they now admit with safety the passage of a larger class of vessels than before improvements were effected.

The following correspondence, copied from the records of the Board of Trade, Milwaukee, upon the subject of insurance, is interesting, as it indicates clearly, the effect of obstructions at the mouths of harbors upon the minds of those interested in lake navigation:

MILWAUKEE, *June* 22, 1855.

DEAR SIR: Great complaints are being made by vessel-masters of the condition of the Buffalo Harbor, which is represented as being difficult of entrance under the most

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favorable state of weather. It is also represented that the underwriters are declining risks to that port upon vessels of large tonnage. If you have any certain information on this subject, and of the prospects of repairs contemplated, you will greatly oblige me by communicating such facts in the premises as you possess.

I am, very respectfully, your obedient servant,

HORATIO HILL,
President of the Board of Trade.

J. W. WEEKS, Esq.,
President.

MILWAUKEE, *June 22, 1855.*

DEAR SIR: I am in receipt of your favor of this date, relative to the condition of the harbor at Buffalo. In reply, I have to state that I am informed by the marine inspectors that a sand-bar of considerable magnitude has formed at the mouth of the (Buffalo) harbor; that the channel is narrow, not exceeding 50 feet, and difficult of entrance even in smooth water, and nearly impossible for vessels of large tonnage or deep draught, to make the entrance without grounding, and if attempted during even a moderate gale hazard and peril are very great, as the vessel may be driven upon the State works a total loss. I am informed that it will require an expenditure of about $6,000 to remove the obstruction, and that the city authorities are wholly negligent, whilst the business men of the city refuse to contribute so considerable a sum. It is necessary to insure safe entrance to our vessels. I am not aware that any risks have been declined, or any additional premiums contemplated for risks to that port; but should this state of things continue, it may well be doubted if underwriters imprudent enough can be found to assume risks certain to encounter such extraordinary peril.

I am, very respectfully,

J. W. WEEKS,
President.

HORATIO HILL, Esq.,
President.

Sail vessels and steamers on the Northwestern lakes, not including western New York and Pennsylvania.

[Taken from United States census of 1880.]

States.	No. vessels.	Average tonnage.	Total tonnage.	Value per ton.	Total value.
Sail vessels.					
Ohio	196	287	56,275	$25	$1,406,300
Michigan	470	132	62,105	25	1,552,625
Illinois	275	242	66,528	25	1,663,200
Wisconsin	258	196	50,800	25	1,270,000
Total	1,199		235,708		*5,892,125
Steamers.					
Ohio	117	328	38,353	55	2,124,700
Michigan	397	167	66,457	07	4,508,725
Illinois	89	151	13,468	62	847,800
Wisconsin	114	113	12,977	59	769,500
Western New York	204	323	66,064	61	4,038,100
Pennsylvania	26	960	24,969	65	1,630,100
Total	947		222,288		13,918,925
Aggregate					19,811,050

*Not including western New York and Pennsylvania.

A reduction of 2 per cent. on the above amount of vessel property shows that a saving of $396,221 per annum is made over the governing rates of insurance in 1855.

The rates of freight at the present time are much lower than before harbor improvements were made.

An extract taken from the records of the Milwaukee Board of Trade, Chamber of Commerce, is as follows:

"JANUARY 19, 1853.—Wells & Hill agree to freight for C. H. Wheeler 2,000 barrels of provisions by steam to Buffalo within two weeks of clearance of first propeller in the spring, at 75 cents per barrel freight."

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The average of freight on flour to the "sea-board" in 1886 has been 32 cents per barrel from Milwaukee.

As high as 32 cents per bushel for wheat has formerly been paid. This was in 1842, when the schooner *Columbus*, with a carrying capacity of 5,400 bushels, was considered to be a large vessel. Her size and cost ($5,000), as compared with the *Susquehanna*, of 2,500 tons burden and cost of $215,000, shows that a vast stride has been taken in the progress of commerce. In 1860 the rate of 14 cents per bushel for wheat from Milwaukee to Buffalo was common.

(5) Benefits to the community, and general benefits.

The average cost of carrying flour by rail from Milwaukee to the Atlantic seaboard, during the year 1885 (as per annual report of the secretary of the Chamber of Commerce) was 32 cents per barrel.

	Cents.
From January 1 to May 25	43.33
From May 25 to October 1	26.36
From October 1 to December 31	43.33

From November 23 to January 22 the freight on flour by railroad was 50 cents per barrel.

This record shows that during the season of navigation on the lakes the rate of freight on flour was from one-third to nearly one-half less than when navigation was closed, and is one evidence of the benefits derived from harbor improvements.

A saving of 15 cents per barrel on flour (through lake competition) would amount to $400,000 per annum on a shipment of flour from this port, with an output of 2,500,000 barrels.

Assuming a rate of one-half cent per mile per ton to be a fair rate for the transportation of heavy commodities by railroad, the cost of one ton of such freight from Buffalo to Milwaukee, a distance of 612 miles, would be $3.06 per ton.

The average rate of freight on coal by water from Buffalo to Milwaukee has been about 66 cents, or $2.40 per ton less than it would have cost for transportation by rail under the above conditions.

Assuming, however, a saving of only one-half that sum (or a freightage of one-quarter cent per mile per ton by rail) to have been made upon the 710,736 tons of coal received at Milwaukee by lake during the year ending June 30, 1886, the saving effected on this single item of commerce has been $852,883.20 in a single year; or during that period $255,052.72 more than the total expenditure which has been made by the United States Government, together with that of the city of Milwaukee, in the improvement of the Milwaukee Harbor, from 1852 to 1886, inclusive.

To comment further upon the savings made on the freights of lumber, shingles, hides, and other heavy articles would seem to be unnecessary, inasmuch as it has been shown above that the saving upon the freight of one article in one year has been more than three times as much as the "total expenditure" made by the United States Government in the improvement of Milwaukee Harbor.

Respectfully submitted.

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. Army.

H H 3.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

CONDITION OF THE WORK JUNE 30, 1887.

During the past fiscal year the contract for dredging, which was under way at the date of the last annual report, was completed, restoring the harbor to 16 feet in depth, it having deteriorated to 13 feet in depth. The dredged channel, however, is only 75 feet in width, and cannot be expected to remain of that depth unless materially widened by further dredging.

After the passage of the river and harbor act of August 5, 1886, proposals were solicited and received, and opened at Milwaukee, Wis.,

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September 14, 1886, for the cutting down and rebuilding superstructure over the outer section of the south pier, as follows:

Abstract of proposals for cutting down and rebuilding 550 feet of superstructure, south pier, Racine Harbor, Wisconsin, received in response to advertisement dated August 27, 1886, and opened September 14, 1886, by Captain W. L. Marshall, Corps of Engineers.

No.	Name and address of bidder.	Pine timber (190,000 feet, B. M.), per M.	Iron drift bolts (26,147 pounds), per pound.	Pine plank in place (28,000 feet, B. M.), per M.	Iron spikes, 8 inch (2,000 pounds), per pound.	White-oak piles driven (1,700 linear feet), per linear foot.	White-oak timber (7,320 feet, B. M.), per M.	Iron screw bolts (400 pounds), per pound.	Stone (50 cords), per cord.	Framing (190,000 feet B. M.), per M.	Total cost.
			Cts.		Cts.	Cts.		Cts.			
1	W. T. Casgrain, Milwaukee, Wis.	$20.00	4	$17.00	5	45	$50.00	6	$10.92	$16.50	$10,475.80
2	Horatio Truman and George Cooper, Manitowoc, Wis.	19.00	4	16.00	5	50	50.00	6	10 00	13.00	9,632.44
3	George H. Sager, Kenosha, Wis.	18.50	4	15.50	5	50	50.00	6	10.50	12.75	9,500.88
4	Hiero B. Herr & Co., Chicago, Ill.	16.00	4	13.00	5	30	40.00	5	10.00	15.00	8,905.16
5	Christopher H. Starke, Milwaukee, Wis.	19.00	4	16.00	5	50	50.00	6	10.00	13.00	9,632.44
6	F. M. Knapp and E. Gillen, Racine, Wis.	18.75	4	15 25	4½	45	50.00	6	9.50	12.25	9,301.36

With approval of the Chief of Engineers, a contract was entered into September 29, 1886, with Hiero B. Herr & Co., the lowest responsible bidders for this work, who, under their contract, dated September 29, 1886, cut down and rebuilt 745 linear feet of the south pier, and protected this work by guard-piles and waling.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

It is proposed to expend these funds in dredging the 16-foot channel to 150 feet in width, and to extending the south pier towards completion. The project for extending the south pier is contained in the Report of the Chief of Engineers for 1883.

The work is necessary for arresting the drift of sand into the harbor, and to reduce the funnel-shaped entrance to prevent disturbance within the harbor by waves entering the present wide mouth. This work is not urgent and may be delayed. The work of dredging, however, is now necessary, and should be done at the earliest practicable moment.

Money statement.

July 1, 1886, amount available		$1,117.50
Amount appropriated by act approved August 5, 1886		10,000.00
		11,117.50
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$9,673.23	
July 1, 1887, outstanding liabilities	670.23	
		10,343.46
July 1, 1887, amount available		774.04

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Amount (estimated) required for completion of existing project.....$25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1887.

SIR: The following report upon the improvement of Racine Harbor, Wisconsin, for the fiscal year, is respectfully submitted:

The contract of Mr. S. O. Dixon, of date May 28, 1886, for dredging between the harbor piers at Racine, was in force on the 30th of June, 1886. At that time he had made two cuts of the dredge to a depth of 16 feet and a width of 50 feet for the whole length of the channel between the piers. Subsequent to that date the dredged channel was widened to 70 feet. Total quantity of dredged material excavated and removed under this contract was 11,555 cubic yards. Under the appropriation made by Congress on August 5, 1886, for the improvement of rivers and harbors, the amount provided for the improvement of Racine Harbor was $10,000.

Advertisements were inserted in the daily newspapers on the 27th of August inviting proposals for cutting down and rebuilding 550 running feet, more or less, of the superstructure of the outer section of the south pier, which were opened at noon on the 14th day of September, 1886. Messrs. Hiero B. Herr & Co. were the lowest bidders, and on the 29th of September they entered into contract to do the work.

Operations were commenced early in October, and continued until the end of November, at which time a length of 318.6 running feet of the superstructure was completed, with the exception of the plank decking and protecting the pier with piles. Extremely cold weather prevented further work in 1886. The work was resumed in April, 1887, and continued until the present month.

The total length of superstructure which has been cut down and rebuilt under this contract is 745.7 running feet, of which 541.4 feet is 20 feet in width and 204.3 feet is 16 feet in width. The whole length of the superstructure has been protected by driving white-oak piles along the channel-face of the pier, which are capped with 12 by 12-inch oak timbers; the timbers and piles being secured to the pier by screw bolts. Thirty-nine cords of large stone were put into the outer crib of the north pier to supply a deficiency of that material caused by the former ballast running through the grillage of the crib.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The trade and population of Racine are growing steadily. One feature which marks an advance in its prosperity is the activity which is apparent in the improvement of its streets; also its system of water supply from Lake Michigan, which is nearly completed, with its accompanying system of sewerage, now well under way. The protection of its lake frontage by pile work, etc., also attests to its increasing importance as a city.

The nearest collection district is Milwaukee, Wis.

The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry, $249,212.89.

The arrivals and departures of vessels at this harbor during the past fiscal year, as given by the collector of the port of Milwaukee, were as follows:

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	579	364,586	579	364,586
Sailing vessels	378	51,084	374	48,416
Total	957	415,670	953	413,002

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H H 4.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

CONDITION OF WORK JUNE 30, 1887.

In accordance with the project for the expenditure of the money appropriated by the act of August 5, 1886, approved by the Chief of Engineers, proposals for cutting down and rebuilding 415 feet in length of superstructure over a section of the south pier were solicited by public advertisement, and received and opened at Milwaukee, Wis., September 14, 1886, as follows:

Abstract of proposals for cutting down and rebuilding 408 feet of superstructure, south pier, Kenosha Harbor, Wisconsin, received in response to advertisement dated August 27, 1886, and opened September 14, 1886, by Capt. W. L. Marshall, Corps of Engineers.

Articles.	1. W. T. Casgrain, Milwaukee, Wis.	2. Horatio Truman and George Cooper, Manitowac, Wis.	3. George H. Sagor, Kenosha, Wis.	4. Hiero B. Horr & Co., Chicago, Ill.	5. Christopher H. Starke, Milwaukee, Wis.	6. F. M. Knapp and E. Gillen, Racine, Wis.
Pine timber (112,000 feet, B. M.) .per M..	$20.00	$19.00	$18.50	$16.00	$19.00	$18.50
Drift-bolts (16,000 pounds)..per pound..	.04	.04	.04	.04	.04	.04
Pine plank, in place (5,000 feet)..per M..	17.00	16.00	15.50	13.00	16.00	15.00
Iron spikes, 8-inch (350 pounds), per pound	.05	.05	.05	.05	.05	.04½
White-oak piles driven (1,230 linear feet), per linear foot	.45	.50	.48	.35	.50	.48
White-oak timber, in place (5,400 feet, B. M.), per M	50.00	50.00	50.00	45.00	50.00	50.00
Iron screw-bolts (1,350 pounds), per pound	.06	.06	.06	.05	.06	.06
Framing (112,000 feet, B. M.)....per M..	17.00	13.00	12.25	15.00	13.00	12.00
Total cost	5,791.00	5,287.50	5,120.40	4,935.50	5,287.50	5,088.15

With approval of the Chief of Engineers, a contract was entered into September 29, 1886, with Hiero B. Herr & Co., the lowest responsible bidders for this work, who, during the year, completed the work contracted for satisfactorily. The completion of this contract finds the piers in fair condition except, within the shore line at the north pier, where 60 feet of superstructure were carried away by storms during the winter of 1885–'86, the removal of which has caused erosion to a damaging extent upon the shore line of the basin near the pier.

The sand is piled up against the north pier for 900 feet beyond the original shore-line, and great quantities of it are annually blown over the pier into the channel-way from these accretions.

In 1876–'77 this harbor was deepened to 15 feet in depth, but the appropriations made have been continually much less than the engineer's estimates, and consequently insufficient for the maintenance of the piers and channel depth. The consequence has been that the harbor cannot be entered now by vessels drawing over 10 feet, and the deterioration, if allowed to proceed further, will practically close the harbor. Not only have the appropriations been insufficient to make further progress towards the completion of the harbor possible, but have not even allowed the work already done to be preserved and maintained.

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PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

These funds are to be used in restoring the harbor to 15 feet available depth of navigation, and to extending the south pier towards completion. The pier extension is not urgent, but $8,000 is imperatively needed to restore the channel to its proper and former depth, and is the least amount that will be effective.

Money statement.

July 1, 1886, amount available		$1,362.20
Amount appropriated by act approved August 5, 1886		5,000.00
		6,362.20
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$752.74	
July 1, 1887, outstanding liabilities	62.29	
		815.03
July 1, 1887, amount available		5,547.17
Amount (estimated) required for completion of existing project		41,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1887.

SIR: The following report upon the harbor of Kenosha, Wis., is respectfully submitted:

The sum appropriated by act of Congress of August 5, 1886, for the improvement of this harbor was $5,000. On the 27th day of the same month proposals were solicited of bidders, through advertisement in the daily papers, for the cutting down and rebuilding of the superstructure of the inner section of the south pier 408 feet in length, more or less. Bids for doing the work were opened at noon on the 14th of September, 1886. The lowest bidders were Messrs. Hiero B. Herr & Co., who were awarded the work, a contract for doing which was entered into by them on the 29th day of the same month.

Active operations were not commenced until late in May, by reason of the difficulty experienced by the contractors in obtaining timber, as their demands upon the mill-owners were large for a supply of that material for the several works which they were under contract to perform. The section of superstructure, which is 412 running feet in length, has been cut down and rebuilt, but the pile protection to the same is not yet completed. It is expected that this will be finished before the 20th day of July.

I took soundings in the harbor channel on the 13th day of last month, a plat of which was submitted. This plat shows that with the stage of water at mean lake level, a vessel drawing 10½ feet of water could not enter the harbor in calm weather without taking ground.

The coal merchants and lumber dealers are particularly desirous of increasing the depth of water, as they say their business has suffered severely through this cause. The city council of Kenosha has appropriated the sum of $1,000 to be applied to dredging purposes, and I believe they have also applied to you for such assistance as you may be able to give towards effecting a better entrance into the harbor.

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

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COMMERCIAL STATISTICS.

The following are some of the leading articles of manufacture, as obtained by the chairman of the harbor committee:

	Quantity.	Value.
Malt extract		$100,000
Flour, barrels	45,000	
Spring-beds, number	100,000	
Fanning-mills, do	500	
Malt, bushels	640,000	
Wagons, number	10,722	
Engines and skeins		75,000
Lumber used in manufacturing, feet, B. M	8,500,000	
Grain tile	500,000	
Brick	5,000,000	
Product of brass-rolling mill		24,600
Beer		60,000
Receipts tan-bark, cords	11,000	
Coal, tons	12,000	

The total value of manufactures is upwards of $3,000,000.
The nearest collection district is Milwaukee, Wis.
The nearest port of entry is Milwaukee, Wis.
Amount of revenue collected at the nearest port of entry, $249,212.89.
The arrivals and departures of vessels at this harbor during the past fiscal year, as given by the collector of the port of Milwaukee, were as follows:

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	88	9,061	84	8,965
Sail vessels	164	19,771	161	18,771
Total	252	28,832	245	27,736

H H 5.

IMPORVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

CONDITION OF WORK JUNE 30, 1887.

Work at this harbor during the past fiscal year has been executed by the method of hired labor and the purchase of materials in the open market, this method being most economical and advantageous to the United States.

During the fiscal year ending June 30, 1887, 208.8 linear feet of the north pier has been completed and 96 linear feet of the south pier.

The north pier, where damaged by storms and ice during the winter of 1886–'87, was repaired, and ballast added to nine cribs of the north pier, to replace the filling washed out by storms.

The report of Assistant Engineer W. H. Hearding, in local charge of the work, herewith gives all details concerning the annual progress.

The north pier now reaches to the 12-foot curve as it existed in 1879, but the advance of the fore-shore is very rapid, and the piers will have to be materially increased in length in the near future.

The work is not yet far enough advanced to be of material benefit to the commerce of the place, although it is used to a slight degree for light-draught boats.

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The harbor is being created upon an exposed sandy coast, in shallow water, remote from shelter, which makes its construction difficult and expensive.

For the sake of economy the appropriations for this work should at least be made sufficient to complete it to the degree that it may be utilized before the piers are rotten, and require renewal above the water-line.

An appropriation of $30,000 will allow the completion of both piers to the 12-foot contour as it existed in 1879, and sufficient dredging beyond the old shore-line and within the harbor to admit of its use to the extent at present demanded by the interests of the place.

The proposed "interior basin" is to be dredged entirely within the shore-line, now above high-water mark. The above estimate is to dredge that part of the harbor only which lies outside the shore-line of 1879.

PROPOSED APPLICATION OF FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

The funds now available are sufficient only for watchman and contingent expenses and maintenance, or to repair possible minor damage from unforeseen causes.

The funds asked for the fiscal year ending June 30, 1889, are to be used in the completion of the piers and in dredging the entrance and a portion of the outer basin, to serve as a harbor during the construction of the inner basin, and in dredging and revetting the passage from the outer to the inner basin.

The prospective commercial importance of the harbor is treated in the Annual Report of the Chief of Engineers for 1882, page 2165.

The object to be attained by the construction of this harbor and the desires of the citizens in reference to it are stated in the Report of the Chief of Engineers for 1880, pages 1940 to 1947.

At present there is but little transportation to and fro by water, the boats being compelled to land at an open pier-head.

Traffic by water is almost confined to the lumber trade.

The pier at which boats landed having been rendered useless by partial destruction, vessels of sufficiently light draught have used the incomplete harbor to a limited extent.

Money statement.

July 1, 1886, amount available		$1,142.19
Amount appropriated by act approved August 5, 1886		20,000.00
		21,142.19
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$11,781.08	
July 1, 1887, outstanding liabilities	43.00	
		11,824.08
July 1, 1887, amount available		9,318.11

Amount (estimated) required for completion of existing project	71,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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REPORT OF MR. W. H. HEARDING, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 30, 1887.

SIR: I have the honor to submit the following report upon the improvement of Waukegan Harbor, Illinois, during the past fiscal year.

In the appropriation bill passed by Congress for the improvement of rivers and harbors, and which became a law the 5th day of August, 1886, the sum designated for the improvement of Waukegan Harbor was $20,000. For economic reasons this improvement has been made chiefly by purchase of materials and hired labor, and therefore no delay was occasioned in resuming work under this act. Operations were commenced on the 1st of September, and prosecuted satisfactorily from that date until the 30th of November, the results being the construction of 208.8 running feet of extension to the north pier, which is of pile-work. This extension has carried the pier to the line of the natural depth of 12 feet of water, as it existed in 1879 before improvements were commenced, which is as far as it was proposed, under the project, to carry the pile-work. When the pile-driving machine was moved to the shore it was taken along the beach to the alignment of the south pier, where it was laid up for the winter, in readiness for the work of its extension. Two hundred and thirty white-oak piles, each 31 feet long, were purchased during the winter, and delivered upon the beach near the south pier, at 20 cents per linear foot, for this extension.

In former reports mention has been made of the effects of the storms upon the sand overlying the clay, which material forms the bed of the lake in this locality. This effect was very marked during a succession of storms which occurred in the latter part of November.

The sheet-piles of the outer section of the north pier (No. 16) were washed out and replaced three times before they could be secured in the work. The waves removed the overlying sand down to the top of the clay, leaving a depth of 19½ feet of water in this section. Some little time was occupied in collecting the materials scattered along the shore, but otherwise the loss sustained was trifling.

The storms in December, 1885, shattered the bridge-pier, owned by private parties, so seriously that it was not considered worth repairing, and in view of the facilities which it is expected will shortly be available in the harbor basin, a temporary platform has been erected, upon which lumber has been delivered in cargoes of from 100,000 to 140,000 feet, B. M. The storm of the night of March 23, of this year, severely tested the stability of the north pier extension. As soon as the heavy body of ice (some 14 feet in height) had melted from the top of the pier its effects became visible. Thirteen of the tie-rods were found to be broken, and others were bent so as to require straightening. One section of the pier (No. 11) was forced to the southward a distance of 10 inches. The oak wales and binders of this section were broken, and some of the sheet-piles disturbed. The water on the north side of the outer four sections was deepened by the removal of the material from the lake bed to a depth of 18 feet, and this depth prevailed around the east end of the pier. The stone ballast inside the pier, which, at the time of suspension of work in 1886, was up to a height of 1 foot above datum, showed a depth of 4 feet of water over it when the ice was gone. Nine of the outer sections have been partly supplied with ballast, where deficient, the top of which, in the two outer sections, is now up to datum, and in the remaining sections the depth of water is 3 feet below that level.

Work upon the south pier was resumed by the driver on the 24th of May, since which time an extension of 96 feet in length of pier has been built, comprising sections 9, 10, and 11, and some of the piles in the side rows of section 12 are driven. The available funds will complete the five sections, or 160 feet of the south pier extension, and provide necessary ballast for the north pier. The accretions to the northward of the harbor have formed extensively during the past year. A very narrow channel of from 7 to 14 feet in depth is available for light-draught vessels, immediately alongside the north pier, but to make it available for commerce extensive dredging will be necessary. The extension of the south pier 160 feet will lessen the disturbance in the basin during southeasterly weather. To complete the work on outer basin under the present project, with 300 feet extension to each pier, would cost as follows:

For 300 feet of crib extension to north pier, 20 feet wide	$22,500
For 300 feet of pile extension to south pier	16,500
For 75,200 cubic yards of dredging in channel and basin, at 20 cents	15,040
Total	54,040

Very respectfully, your obedient servant,

W. H. HEARDING,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

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COMMERCIAL STATISTICS.

The following are some of the commodities of trade, as furnished by John Powell, esq., mayor of Waukegan:

Receipts:		
Lumber	feet, B. M..	6,000,000
Shingles		1,500,000
Laths		1,500,000
Coal	tons..	18,500
Salt	barrels..	5,000
Nails	kegs..	2,000
Iron	tons..	400
Tan bark	cords..	1,900
Hides		57,000
Shipments:		
Fish	tons..	100
Sand and gravel	cars..	6,000
Ale and beer, money value		$350,000
Money value of business transacted by merchants		$2,763,500

The nearest collection district is Chicago, Ill. The nearest port of entry is Chicago, Ill.

Amount of revenue collected at the nearest port of entry is $4,620,773.76.

Arrivals of vessels, 76; departures, 76.

H H 6.

IMPROVEMENT OF THE FOX AND WISCONSIN RIVERS, WISCONSIN.

During the fiscal year ending June 30, 1887, work on the Fox and Wisconsin rivers, under the river and harbor acts of July 5, 1884, and August 5, 1886, has been done as follows:

ON THE WISCONSIN RIVER.

During the summer of 1886, two of the dams on the Wisconsin River were repaired preparatory to the work of an observation party, which was maintained on this river during July and August, 1886. The observations taken were to ascertain the low-water slopes, depths available for navigation at low water, and other information for the use of the Board of Engineers, in discussing the practicability of improving the Wisconsin River by wing-dams.

These observations were reduced and forwarded to the Chief of Engineers November 17, 1886. The Board of Engineers submitted a report, based upon the results of the observations named, to the Chief of Engineers, which was referred to the last Congress and published in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

The conclusions of the Board were adverse to this method of improvement, and they recommended that no more work be done on the wing-dams in the bed of the river directed to securing an open river channel.

No further work is, therefore, contemplated on the Wisconsin River.

ON THE FOX RIVER.

Upper Fox.—The necessary work was done for maintaining the navigation of the river from Portage to Lake Winnebago, including the repairs to locks and dams and the maintenance of existing depth of navigation by dredging.

Lock-tenders' houses were built at White River and Eureka locks; 46,649 cubic yards of sand and gravel were dredged from bars in the

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channel below Montello; new gates were built for the Grand River Lock, and the gates at White River, Princeton, and Eureka locks repaired; a washout in the Eureka Dam was repaired, temporarily, but this dam must be rebuilt. An embankment or levee 102 feet long was constructed at the White River Lock.

Lower Fox.—The work in progress at the close of the last fiscal year at Neenah and Menasha, in accordance with the recommendations of the Board of Engineers, September 17, 1884, approved by the Secretary of War, December 10, 1884, to comply with the provisos attached to the river and harbor acts of August 2, 1882, and July 5, 1884, were continued during the past fiscal year.

The Menasha Dam, 402 feet in length, with four sluice-ways 20 feet each in width and 7½ feet in depth, was completed and is in use.

The removal of 400 feet in width of the Neenah Point was completed, 57,412 cubic yards of material having been removed by dredging.

The rock drilling and blasting in Menasha outlet to Lake Winnebago, to give a channel-way 95 feet wide and 6 feet below the crest of the Menasha Dam, was completed and the material removed, except an inconsiderable amount of dredging to remove inequalities; 5,487 linear feet of holes were drilled; 2,159 charges exploded, and 628 linear feet of channel excavated; 6,982 cubic yards of rock and 10,292 cubic yards of gravel were removed from the channel.

Dredging was begun above the rock cut to continue the 6-foot channel to Lake Winnebago.

The left abutment to Rapid Croche Dam, injured by the flood of 1881, was rebuilt of masonry in cement mortar, and the dam repaired, and a sluice-way placed therein.

The old De Pere Lock was thoroughly renovated, and the bottom of the lock-chamber lowered by rock excavation 2½ feet, increasing the capacity of the lock that much in navigable depth.

The old timber lock at the Cedars was removed and a new lock of cut stone built on its site during the spring of 1887.

The De Pere Dam was completed by closing the openings therein; putting on its comb or crest and backing it with gravel and clay.

Current repairs to lock-gates, dams, and canal banks were made throughout the line as needed, and the channel depths maintained by dredging; repairs to the dredges, boats, and scows were undertaken, and the plant kept in serviceable condition thereby.

The report of Assistant Engineer C. A. Fuller, hereto attached, gives full details of the location and amount of all work done from Montello to Green Bay, and the materials expended in the work.

Navigation was continued during the season of 1886 until closed by ice November 23, 1886. It was resumed throughout the line April 23, 1887, and continued up to the date of this report, except for nine days in June, when temporarily suspended through the Menasha Lock, which was closed for repairs.

Extraordinary low water characterized the season. The depth of navigation in the upper Fox reached, for short times, until the bars could be removed by dredging, 2½ feet. Boats drawing 5½ feet could run from Green Bay to Menasha during the entire season, except during the months of August and September, when, on account of the mills taking from the pools, above the Appleton and Menasha dams, water in excess of the discharge of the Fox River, and thus reducing the levels of Lake Winnebago and Little Lake Butte des Morts below the crests of the dams, navigation was made precarious for boats drawing more than 3½ feet of water.

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This evil is increasing, and if the mills can not be confined to taking the surplus water only, or that which would otherwise flow over the crests of the dams, the improvement of the Fox River should not continue.

The facts were reported by me to the Chief of Engineers August 16, 1886, and referred by the War Department to the Department of Justice, which has instituted proceedings against the water-power users at Neenah and Menasha, in the United States circuit court for the eastern district of Wisconsin, to restrain them from drawing water below the crest of the Menasha Dam. The suit is contested, and meanwhile navigation is again, this season, since the close of the fiscal year, suffering even more severely than last year from this cause. The mills are increasing in number, and water-rights are still being sold by the water-power companies, although the low-water discharge of the Fox River has already been much exceeded. The expenditure of further appropriations for this stream should be made contingent upon the success of the Government suit now pending. If the United States can not maintain the levels of the pools and depth of navigation as established by their officers, the work is, or can always be rendered, valueless.

All expenditures for the improvement of the Fox River and for new works have been made from the appropriations for the Fox and Wisconsin River, July 5, 1884, and for the Fox River below Montello, August 5, 1886.

PROPOSED APPLICATION OF FUNDS AVAILABLE FOR EXPENDITURES DURING THE FISCAL YEAR ENDING JUNE 30, 1888.

The balance of the funds available and on hand will be expended in completing the removal of material from the blasted channel at Menasha, and in dredging in the vicinity of the Menasha Channel.

It will be observed that the balance now on hand, and reported in the financial statement herewith, is not all available for work on the Fox River. Of the amount reported, $4,293.53 is a balance remaining over from the appropriation of $25,000, made in the special act of March 3, 1875, "to aid in the improvement of the Fox and Wisconsin rivers, in the State of Wisconsin," and applicable only to acquiring land for sites and pay for flowage of lands, etc.

Ten thousand dollars, appropriated by river and harbor act of July 5, 1884, "to be used for maintaining the channel between De Pere and Green Bay," and $6,000, "or so much thereof as may be necessary," etc., appropriated by the river and harbor act of August 5, 1886, for a levee at Portage "to prevent overflow of the Wisconsin River into the Upper Fox River, so as to prevent injury to the Government works on Fox River," in all, $20,293.53, is not available for the purpose of improving Fox River.

Of these amounts the first named is used principally for the legal expenses connected with defending the suits for flowage damages against the United States now in the courts of Wisconsin.

The second amount is retained until it may be needed to "maintain" the channel from De Pere to Green Bay, which has undergone no deterioration, and has required no "maintenance;" and the third amount is withheld in the Treasury because, during the fifteen years of Government possession of the works on the Fox River, no levee at Portage has ever been found to be or considered to be "necessary to prevent injury to the Government works on the Fox River."

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It is respectfully recommended that the two last-mentioned sums, amounting to $16,000, be made available for work on the Fox River, or that the former acts be repealed as far as relates to them, or that the terms of the acts may be so modified as to allow the sums to be expended.

PROPOSED APPLICATION OF THE FUNDS ASKED FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

The estimate herewith submitted is for continuing the work under the project contained in the report of the Board of Engineers, dated September 17, 1884, approved by the Secretary of War December 10, 1884, (see Report of the Chief of Engineers, U. S. Army, for 1885, pages 2041 to 2046, inclusive), as further modified by authority of the Chief of Engineers, upon the recommendation of the Board of Engineers for fortifications and for river and harbor improvements, May 14, 1886, which project as modified contemplates the rebuilding of the Cedars Lock, the renovation of the old locks as they require it, and the deepening and widening the channel of the Fox River throughout to 6 feet depth and 100 feet width, without reference to the original project.

This work forms part of the original project, the object of which was to secure a cheap route of transportation from the Mississippi River to the Great Lakes and Atlantic sea-board; the advantages of which are set forth in numerous reports, and especially in the report of Major G. K. Warren, Corps of Engineers, in the Report of the Chief of Engineers for 1868, page 357, and in the report of the Select Committee on Transportation Routes to the Sea-board, United States Senate, 1874.

The present status of this project may be seen from the report of the Board of Engineers, contained in House Ex. Doc. No. 65, Forty-ninth Congress, second session.

It is proposed to apply funds given by Congress to first improve the navigation of the river by deepening and widening the channels throughout, by rock excavation and dredging, to the full capacity of the existing locks, in order that the full benefit of the locks already built will be attained and remain available.

The valley of the Fox River is about the most thickly settled portion of Wisconsin, and although the freight actually carried by water may form but a small part of the commerce of such important towns along its course as Portage, Berlin, Oshkosh, Fond du Lac, Menasha, Neenah, Appleton, and Kaukauna, yet all the freight, especially heavy freights, to and from these places are lowered to near the price of water carriage during the season of navigation, and the river competition is therefore of such value that the works should be maintained and the navigation improved, at least to the extent contemplated by the modified project stated above.

The practice of the water-power owners, however, along the Lower Fox of using the pools created by the dams for purposes of navigation simply as storage reservoirs for water for milling purposes, without any regard to the rights of the public to the full benefits of the navigation established by the United States works, will, if some method of restraint cannot be had, render of no avail the large disbursements made by the Government upon this stream.

The nearest collection district is Milwaukee, Wis. The nearest port of entry is Milwaukee, Wis.

Amount of revenue collected at the nearest port of entry during the fiscal year, $249,212.89.

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Money statement.

July 1, 1886, amount available		$68,701.16
Fuel sold to officers, deposited to credit of appropriation		175.00
Amount appropriated by act approved August 5, 1886		56,250.00
		125,126.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$80,554.98	
July 1, 1887, outstanding liabilities	270.90	
		80,825.88
July 1, 1887, amount available		44,300.28
Amount (estimated) required for completion of original project, Fox and Wisconsin rivers		1,965,663.00
Amount (estimated) required for completion of existing project, Fox River		546,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

The expense of maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams, and for lock-tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of the river and harbor act approved July 5, 1884.

A detailed statement of the expenditures under this latter appropriation accompanies this report.

Under the indefinite appropriation for the "operating and care of canals and other works of navigation," it is proposed to renew the wooden lining of two of the old timber-locks; to build new lock-gates for Little Chute Combined, Appleton Second, and Kaukauna locks; to maintain the existing depth of navigation in river and canals by dredging; to keep in general repair locks, dams, and canal banks, and pay for lock-tenders' services and superintendence.

Money statement.

July 1, 1886, amount appropriated by act approved July 5, 1884		Indefinite.
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		$42,061.65
Amount (estimated) for expenditure in fiscal year ending June 30, 1888.		43,650.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

FOX RIVER.

REPORT OF MR. C. A. FULLER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Appleton, Wis., July 16, 1887.

CAPTAIN: I have the honor to submit the following report of operations on the improvement of the Fox River, Wisconsin, from Montello to Green Bay, for the fiscal year ending June 30, 1887.

Operations during the year were confined principally to renovating the old lock at De Pere and lowering the bottom of the lock-chamber and the lower gate recesses

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2½ feet by rock excavation; to the completion of the repairs of Rapid Croche Dam; to rebuilding of the Cedars Lock with stone; to drilling, blasting, and removing rock from the channel of Menasha River; to completing the construction of the new dam at Menasha; to widening the Neenah outlet of Lake Winnebago by dredging; to deepening and widening the channel of the river by dredging; to making repairs to boats and dredges, and incidental repairs to locks, dams, and canal banks.

Navigation was continued until closed by ice on the 23d of November. It was partially resumed on the 10th of April, 1887, and wholly so on the 23d of the same month, and was maintained to the present date, except for nine days during the month of June, through the Menasha Lock, which was closed for repairs.

Boats drawing not exceeding 5½ feet of water could run during the whole season of navigation between Green Bay and Menasha, excepting in the months of August and September, when the mills had drawn the water so low below the crests of the Appleton and Menasha dams that there was but a precarious navigation for boats of 3½ feet draught between Appleton and Lake Winnebago. Again, on the 13th, 20th, and 27th of June, 1887, the water was drawn by the mills below the crest of the Appleton Dam from 4½ to 10 inches, which seriously affected navigation between Appleton and Menasha.

During the low-water season there was but 2½ feet of water on some of the bars between Oshkosh and Montello.

The following outline of operations at each point between Montello and Green Bay, under separate heads, viz: "Operating and care of canals and other works of navigation," and "improving Fox River," is respectfully submitted:

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION.

De Pere Lock.—The remains of an old coffer-dam were removed by Dredge No. 1; the lower crib wing-walls were raised, repaired, and backed with clay, coffer-dams put in above and below the lock, and 134 linear feet of coffer-dam built along the left side. A 10-inch centrifugal pump was placed, the pump-engine set up, and the water pumped out. Large quantities of snow and ice were removed from the lock-pit. All of the planks were stripped from the walls, the upper tier of posts and the coping timbers removed, the lower tier of posts dressed off to receive new planking, new posts and coping framed, and the lock replanked. The lower hollow quoins were taken out and replaced by new ones backed with cement masonry. The valve rods and suspension straps of the upper gates were straightened and repaired. Two new lower gates were framed and placed. One hundred and sixty-three cords of rock were excavated from the lock bottom, lowering the lower miter-sill 2½ feet, and the rock in the lower recesses were cut down plumb. A new lower miter-sill was framed, placed, and secured by fifteen 1¼-inch wedge-bolts to the solid rock, and the heel of the cheek pieces bolted to the chord by two 1-inch bolts. The seams in the rock bottom were filled with stone and cement. Eighteen anchor-bolts were placed in the chamber walls. The crib-work of both upper wing-walls was repaired and replanked. The suspension columns and maneuvering gear were placed and secured, four new capstan platforms built, four new snubbing-posts put in, and the old ones repaired and braced. The fore-bay of the lock was cleaned out, the pump taken out, and the engine and boiler cleaned and laid up. The coffer-dams were removed by a dredge-boat sufficiently to allow of the passage of boats, and navigation opened through the lock on the 10th of April.

There were purchased and expended, 84,158 feet, B. M., of pine lumber; 18,818 feet, B. M., of oak lumber; 530 pounds of drift-bolts; 5,500 pounds of nails and spikes; 1,490 cubic yards of clay; 300 pounds of Ætna powder; 300 exploders; 700 linear feet of safety fuse; 21 barrels of cement; 50 barrels of sand; 76 cords of wood, and 15 tons of anthracite coal.

Little Kaukauna Lock and Dam.—No repairs were made.

Rapid Croche Lock.—One lower gate was taken out, a valve-rod repaired, and the gate rehung. Two new diamond blocks were framed and placed, and the anchor-straps to one lower gate and two capstan platforms were repaired.

The left bank of the canal was raised and strengthened by Dredge No. 1. Two hundred and sixty-six cubic yards of clay were placed.

Rapid Croche Dam.—The work of repairing the coffer-dam that was partially carried away by the flood of April, 1886, was completed, and the dam repaired. Two cords of brush were cut, mats made and sunk; six cribs were built and sunk with 30 cords of stone, connections were made, and 187 linear feet planked; 3,910 cubic yards of backing were put in; the débris of the old abutment was taken out, the bed-rock cleaned off, and a coffer-dam put in around the site of the abutment; 234 cubic yards of hardpan were excavated for foundations, and 220 cubic yards of cement masonry laid; 28 linear feet of abutment coping was dressed and laid in cement; eight cribs were built, sunk, and secured in extension of dam, and 40 linear feet of sheet piled; 950 cubic yards of clay were placed in rear of the abutment, 200 cubic yards of clay

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and gravel in rear of the dam, and 100 cubic yards above the sluice-way; crib connections were made between the end of the dam and the sluice-way; the floor and trestle timbers of the sluice-way were framed, placed, and secured, and the needles framed and placed; the pump, engine, and plant were moved to Cedars Lock.

There were purchased and expended 79,275 feet, B. M., of pine lumber; 7,500 feet, B. M., oak lumber; 1,500 pounds of nails and spikes; 1,050 pounds of screw-bolts and washers; 2,830 pounds of drift-bolts; 151 barrels of cement; 275 pounds of cast-iron caps; and 25 cords of wood.

Kaukauna Fifth Lock.—Three new diamond blocks were framed and placed, and the capstan platforms repaired.

Kaukauna Fourth Lock.—One new diamond block was framed and placed. All of the valve-chains were shortened and new guide-strips put on; the capstan platforms were repaired; a leak near the left upper wing-wall was stopped by puddling in 25 cubic yards of clay.

Kaukauna Third Lock.—The valve-chains were shortened, new guide-strips put on, and the capstan platforms repaired.

Kaukauna Second Lock.—New diamond blocks were framed and placed. A washout in the clay backing of the right wall was filled with 60 cubic yards of clay.

Kaukauna First Lock.—No repairs were made.

Little Chute Combined Locks.—Two new snubbing-posts were put in; the lower gate suspension straps repaired; and two new diamond blocks framed, placed, and secured.

Little Chute First and Second Locks.—No repairs were made.

Little Chute Dam.—Slight repairs were made to the fill in rear of the left abutment.

Cedars Dam.—Slight repairs were made to the left abutment, and to the fill behind it.

Cedars Canal.—The stone wall on both sides was repaired and topped out with clay.

Appleton Fourth Lock.—One new diamond block was framed, placed, and secured; and the capstan platforms were repaired.

Appleton Lower Dam.—No repairs were made.

Appleton Third Lock.—Two new snubbing-posts were put in; one capstan platform was rebuilt; 30 cubic yards of clay were puddled behind the head walls; and 30 cubic yards of mud removed from the fore-bay.

Appleton Second Lock.—An upper coffer-dam was built with stop timbers on the breast wall. The platform valves were repaired, and new chains attached, and the upper gates removed, repainted, and rehung. The lower gates were taken out and the irons removed. New gates to replace the old ones were framed; the old valves put in, and the gates hung. All of the anchor-straps were countersunk into the coping. Two sets of new maneuvering and suspension gear were put on, the capstan platforms rebuilt, and the tripods set; 245 cubic yards of frozen mud were removed from the lock; 210 square feet of the lower miter-sill platform were taken up, and 60 cubic yards of clay excavated from below. A timber crib 39 feet by 7 feet by 6 feet was built, filled with stone, a timber platform laid on top and planked with oak boards, and the whole sheet-piled on the upper side. Two cheek pieces and a king-post, were framed and placed in the lower miter-sill, and the sill was secured to the crib-work by 1¼-inch screw-bolts. The flagging below the sill was taken up, and the concrete repaired, 360 cubic feet of dry stone wall were laid in the lower wing-walls, and the canal banks below the lock were repaired. The coffer-dams were removed, and navigation through the lock was opened on the 23d of May.

There were purchased and expended 8,279 feet, B. M., of pine lumber, 972 feet, B. M., of oak lumber, 1,720 pounds of iron stops, 667 pounds of iron, 531 pounds of drift-bolts, 475 pounds of screw-bolts, 48 pounds of spikes, and 10 cubic yards of gravel. Fifteen cords of rubble-stone were received from Menasha Channel.

Menasha Lock.—A portion of the lower wing-wall of this lock tumbled in on the 8th of June, temporarily closing navigation at this point. Coffer-dams above and below were put in by Dredges Nos. 1 and 2, a 10-inch centrifugal pump was set, and the water pumped out. Thirty linear feet, from the hollow quoins down, of dry stone wall were taken out, and replaced by a crib filled with stone. The left hollow quoin was removed and replaced by a new one, and the recess wall slightly repaired. Four new diamond blocks, four capstan platforms, and four new spars were put in, and the gate irons repaired. The pump and engine were removed; the coffer-dams were taken out by Dredge No. 1, and navigation was resumed on the 17th.

There were purchased and expended 13,240 feet, B. M., of pine lumber, 1,206 pounds of drift-bolts, and 309 pounds of screw-bolts and washers.

Eureka Lock.—All of the gates were hauled out and blocked up. The irons were removed from the toe posts and lower arms, and the gates cut off 4 inches at the toe posts to zero at the heel posts. New top arms were framed and put in, gates planked, valve-rods repaired, and the gates rehung. New hand rails and spars were put on; one capstan platform was rebuilt, and a protection crib 8 by 13 feet by 23 inches built around each gate suspension. The road from the highway to the lock-site was repaired.

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There were purchased and expended 7,082 feet, B. M., of pine lumber, 3,567 feet, B. M., of oak lumber, and 100 pounds of nails.

Eureka Dam.—The washout underneath the dam was filled with rubble-stone up to the level of the apron, over which a brush mat 40 by 10 feet by 3 feet was placed, and covered with 753 cubic yards of clay. The washout at the abutment was filled with clay, and the foot of the slope and the right bank of the river were riprapped a distance of 60 feet above the abutment. These repairs are temporary. The dam has a quicksand foundation, and a new one is required at this point.

Berlin Lock.—No repairs were made. Four gates for Grand River Lock were framed at this point, put together, ironed, and towed on a barge to that lock.

White River Lock.—The old gates taken from Princeton Lock were repaired and are nearly ready to be hung.

An embankment 102 feet long, 3 feet wide, and 2½ feet high was built along the right bank of the river about 300 feet to the left of the lock, to protect the low ground at that point.

Princeton Lock.—The old gates which were taken from Grand River Lock were repaired and placed.

Grand River Lock.—The old gates removed and the new ones built at Berlin Lock were hung.

There were purchased and received full sets of gate irons for Grand River, and for new gates and repairs of gates, 26,183 feet, B. M., of oak lumber, 7,082 feet, B. M., of pine lumber, and 600 pounds of nails.

DREDGING.

On February 9, 1887, the line of works under my direction for the Fox River improvement was extended to include from Montello to Green Bay. The dredging done prior to that date between Montello and Berlin is not included in this report.

Dredge No. 1 removed 5,303 cubic yards of soft material from the cut below Kaukauna Fifth Lock, which was placed on dump-scows, towed to deep water in the river, and dumped. On completion of this work the dredge moved to the fifth level of the Kaukauna Canal and commenced dredging. After removing 1,127 cubic yards of mud, the boat was sent to Rapid Croche Dam, to assist in repairing the coffer-dam, etc. The backing to the coffer-dam and to the extension of the main dam was put in and the débris of the old abutment removed by the dredge. It was then moved to a gravel bar about 3 miles above the De Pere Dam, and dredged out 3,500 cubic yards of gravel and clay, which was placed on dump-scows and towed to the dam by the steamlaunch *General Meade* to complete the backing. The dredge was then towed to Cedars Lock. On the completion of that work the boat worked up to Appleton, a new dipper was put on, and the dredge and dumpscows were towed to Menasha by the *General Meade*. It worked in the cut below the lock, taking out 5,052 cubic yards of mud and clay, and put in the lower coffer-dam, and removed both the upper and lower ones while repairs to that lock were being made.

Dredge No. 4.—The cut through the bar above Eureka Lock was completed by the removal of 3,265 cubic yards of sand, and the dredge was then towed to Berlin. Work was suspended six days for repairs of machinery. When finished the boat made a channel through the bar below Berlin Bridge, removing 15,480 cubic yards of sand, and continued working on the bars as far down the river as Delhi, taking out in all 46,381 cubic yards of material, mostly sand. On the 20th of November the work was suspended and the dredge was towed to Oshkosh for repairs.

On June 2 the dredge was towed to Berlin by the tug *Boscobel* and recommenced work on the bars between that point and Eureka Lock, having removed up to the 30th June 16,674 cubic yards of sand, clay, etc.

There were purchased and received for the tugboat *Boscobel* and Dredges Nos. 4 and 5, 113 cords of wood, 18,200 pounds of bituminous coal, 407 pounds of manilla rope, and 134 pounds of cotton-waste.

Dredge No. 5.—The repairs of this dredge having been completed, it was towed to Wilson's Bar, below Grand River Lock, by the *Boscobel* on the 4th of June, and commenced dredging a channel through that bar. On the 30th of month, 11,210 cubic yards of sand and clay had been removed.

IMPROVING FOX RIVER.

De Pere Dam.—The right flume openings in the dam were planked and bulkheaded, and 950 linear feet of oak crest 3 inches by 8 inches was placed and securely bolted. Three thousand five hundred cubic yards of clay and gravel and 47 cubic yards of spalls were put in for backing the dam, completing the work.

There were purchased and expended 32,967 feet, B. M., of pine lumber; 1,500 pounds of spikes; 807 pounds of drift-bolts; 200 carriage-bolts; 30 cords of wood, and 20 tons of coal. Seven cords of rubble-stone and 75 cubic yards of gravel were

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brought from Menasha Channel, and 47 cubic yards of spalls were transported from the Kaukauna quarry.

Kaukauna Dam.—A sluice-way, 75 feet in length and 2.83 feet in depth, below the crest, that was left open in building the dam, was closed by putting in flush-boards.

Cedars Lock.—During the season of suspension of navigation, this lock was entirely rebuilt. The stone for the walls was brought mostly from Menasha, having been dressed for rebuilding the lock at that point. Coffer-dams were put in above and below the old lock, the pump-engines set, and two centrifugal pumps set. The water was pumped out, and 1,000 tons of ice from 2½ to 2 feet in thickness was sawed and removed. Nine hundred and thirty cubic yards of backing were excavated from behind the walls. The old walls were taken down, and 2,477 cubic yards of rubble-stone and all of the old timber were wheeled out; 200 cubic yards of frozen clay were removed from the canal between the lock and the lower coffer-dam; 252 cubic yards of stone were quarried in the chamber and below the lock; a new lower miter-sill was framed and placed, 7 inches lower than the old one and 10 feet further down the lock, and well bolted to bed-rock. The old lower gates were taken out and new ones framed and hung. The old upper gates were cut down and fitted; 220 linear feet of rock was leveled off for foundations to the walls, and 2,085 cubic yards of cement masonry laid up to the level of the bottom of the coping; 254 cubic yards of dry stone were laid in the wing-walls. The coping, steps, and slope coping were laid in cement mortar. The breast wall, platform, and miter-sill were built and the miter-sill set. The recess bulkhead was put in and the valves set. The gate anchors were countersunk in the coping, and the suspension and maneuvering gear placed. Six iron snubbing posts were secured to the walls, capstan platforms built, and hand-rails, fenders, and spars attached to the gates. Eight hundred and sixty-five cubic yards of clay were puddled in rear of the walls near the head, and the remainder of the walls were backed with small rubble and clay as far as was deemed necessary.

The five derricks were taken down and stored, the coffer-dams removed by Dredge No. 1, and the lock was opened to navigation on the 23d of May.

There were purchased and expended 20,378 feet, B. M., of pine lumber; 10,027 feet, B. M., of oak lumber; 3,411 pounds of iron; 141 pounds of steel; 450 pounds of nails and spikes; 2,635 barrels of Milwaukee cement; 80 barrels of Louisville and 22 barrels of Portland cement; 250 pounds Forcite powder; 350 exploders; 650 linear feet of safety fuse; 236 cords of wood; 33 tons of bituminous coal, and 5 tons of blacksmith's coal.

Menasha Dam.—One thousand five hundred and eighty-one cubic yards of hardpan, gravel, etc., were excavated for foundations of abutments, piers, and head wall of sluice-way, and 916 cubic yards of masonry laid. The abutment walls were founded on bed-rock, and the head wall and piers on crib-work. Fourteen thousand seven hundred and eighty-five feet, B. M., of pine timber was framed and placed in the dam, and 24,656 feet, B. M., of pine timber and 16,000 feet of pine plank in the sluice-way. Two thousand one hundred and seventy-six feet, B. M., of pine sheet-piling were put in. The top of the dam was planked with 5,682 feet, B. M., of oak, and 118 linear feet of oak crest, 14 by 14 inches, placed and secured. One hundred and forty-six cords of rubble-stone were placed in the crib-work; 565 cubic yards of gravel were excavated in front and 800 cubic yards in rear of the sluice-way. A protection crib, extending 44 feet down from the left abutment, was framed, placed, and filled with stone. Four Taintor gates, 20 feet each in width, were framed and placed in the sluice-ways, and the maneuvering gear attached. The coffer-dams and old dam were removed and the plant taken to Cedars Lock. The new dam, as completed, is 402 feet in length between the abutments.

There were received and expended 63,138 feet, B. M., of pine lumber; 6,107 feet, B. M., of oak lumber; 4,363 pounds of drift-bolts; 950 pounds of screw-bolts; 2,989 pounds of nails and spikes; 524 barrels of cement; 291 cubic yards of sand; 180 pounds of iron, and 31 cords of wood. There were received from Menasha 53 cords of rubble-stone; from Menasha Lock 394 cubic yards of backing stone, and from Kaukauna quarry 279 cubic yards of pitched face-stone. For constructing sluice-gates, 5,298 pounds of iron; 1,039 pounds of screw-bolts and nuts; 1,000 small bolts; 2,620 pounds of iron castings; 3,056 feet, B. M., of oak lumber; 480 feet, B. M., of pine lumber, and one set of maneuvering gear were purchased and received.

MENASHA CHANNEL.

The work of excavating through rock was continued; 124 lines of holes across the 95-foot channel, from 4 to 8 feet apart, were drilled and blasted. The total depth of holes drilled was 5,487 feet; the number of holes 2,159, and the length of channel 628 feet. This part of the work was completed on the 20th of November, and the drill, scow, tools, etc., taken to Cedars Lock.

The blasted material was removed by Dredge No. 2, placed on flat scows, taken across the river, wheeled out and piled upon the right bank. One thousand four

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hundred and seventy cords of stone and 10,292 cubic yards of gravel were thus disposed of during the year.

There were purchased and expended 1,700 pounds of Forcite powder, 500 exploders, 418 pounds of steel, 214 pounds of iron, and 236 cords of wood.

WIDENING THE HEAD OF THE NEENAH OUTLET.

Dredge No. 3 worked until the 12th of November in removing the point, on which date the boat was towed to Oshkosh for repairs by the tugboat *Dekorra*. Work was resumed on the 3d of June and continued during the month; 57,412 cubic yards of clay, gravel, and hardpan were removed, placed on dumpscows, towed to deep water in Lake Winnebago, and dumped. The total quantity of material taken out since the commencement is 77,861 cubic yards. About ten days' more dredging will complete the work.

There were purchased and expended 99 cords of wood and 76 tons of bituminous coal.

DEEPENING CANALS AND OUTLETS TO LOCKS.

Dredge No. 1 completed the widening and deepening the dredge cut below Rapid Croche Lock; removing 1,369 cubic yards of hardpan and gravel, which was placed on scows, taken to deep water in the river, and dumped.

Dredge No. 2 removed 740 cubic yards of large gravel, cement, rock, etc., from comings left in the Menasha Canal on suspension of work, and widened and deepened the head of the canal, removing 2,678 cubic yards of hardpan and gravel, and also the remains of an old guard-gate.

REPAIRS TO BOATS AND DREDGES.

Steamtug Boscobel.—Portions of the machinery were removed, taken to shop in Oshkosh, repaired, and replaced. New water-wheel arms were framed and put in, and the rims, splash-doors, chocks, deck, and plank-shear repaired. The upper works were extended forward 9 feet, the roof of the new part tinned, and the upper works painted.

There were purchased and expended 2,599 feet, B. M., of pine lumber; 516 feet, B. M., of oak; 150 pounds of white lead; 10 gallons of boiled oil, and 25 pounds of mineral paint.

Steamtug Dekorra.—The upper works were extended forward 9 feet, the roof of the new part tinned, and the upper works painted. One new water-wheel was framed and put in.

There were purchased and expended 2,596 feet, B. M., of pine lumber; 175 pounds of white lead; 12 gallons of boiled oil, and 25 pounds of mineral paint.

Dredge No. 1.—Slight repairs were made to the machinery and the dredge fitted for use as a derrickboat at Cedars Lock while rebuilding.

Dredge No. 2.—Portions of the machinery were removed, taken to Chicago, repaired, and replaced. A new turn-table and new floor to the engine-room were put in; the doctor engine and bed to the hoisting engine were repaired; the dipper handles were riveted, bolted, and new steel racks put on; new steel teeth were riveted to the dipper; iron hand-rails made and placed on the crane; the boiler cleaned and the joints tested, and the roof repaired and painted. There were purchased and expended 1,359 pounds of iron; 77 pounds of steel; 300 pounds of bolt stubs; 56 pounds of spikes; 38 carriage-bolts; 38 steel racks; 1,241 feet, B. M., of pine lumber, and 1,163 feet, B. M., of oak lumber.

Dredge No. 3.—The boat was hauled out on the ways at Oshkosh; all unsound timber and planks removed and replaced by new; new gallows-frame, crane, dipper handle, and spuds made; turn-table, bumper, and dipper put on; the hull calked, painted, and the boat launched. A portion of the machinery was removed, taken to the shop for repairs, repaired, and replaced. There were purchased and expended 8,658 feet, B. M., of pine lumber; 23,510 feet, B. M., of oak lumber; 7,206 pounds of iron; 2,700 pounds of drift-bolts; 27 pounds of steel; 20 pounds of Babbitt's metal; 10 bales of oakum; 2 barrels of pitch; 24 gallons of mixed paint, and 24 pounds of mineral paint.

Dredge No. 4.—Portions of the machinery were removed, taken to the shop in Oshkosh, repaired, and replaced. A bulkhead was built under the A frame and the frame repaired. There were purchased and expended 1,920 feet, B. M., of pine lumber; 200 pounds of drift-bolts, and 239 pounds of iron.

Dredge No. 5.—A part of the A frame was removed, the decayed portions taken out, and new pieces framed in, and the iron work repaired. A portion of the deck was taken up, fifteen new deck-beams put in, and the deck relaid with new plank. Two bulkheads, 20 feet by 4½ feet, were built under the A frame, and new hatchways put

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in the deck and roof; nine graving pieces were put in, portions of the deck and sides calked, and the roof of the cabin repaired and painted. The engines and boiler were cleaned and the boiler was repaired. There were purchased and expended 1,674 feet, B. M., of pine lumber and one bale of oakum.

Dredge No. 6.—Portions of the machinery were removed, taken to the shop in Berlin, repaired and replaced. Two bulkheads, 16 feet in length, were built under the pump-frame; 1,200 superficial feet of the deck was removed, replaced by new and the remainder of the deck repaired; 50 linear feet of top strake and 50 linear feet of wale were replaced by new timbers. The derrick was repaired, the deck and sides were calked, old canvas was removed from the roof, replaced by new, and the roof repaired. The swinging gear, chocks, and two pontoons were repaired. There were purchased and expended 10,165 feet, B. M., of pine lumber, 500 pounds of spikes, 145 square yards of roofing canvas, and 1 barrel of pitch.

Steamlaunch General Meade.—The boat was hauled out, slight repairs were made to the hull, the hull and upper works painted, the machinery repaired, and the boat launched.

MISCELLANEOUS.

The steamlaunch *General Meade* was employed in towing dumpscows for dredge No. 1, in towing scow-loads of materials, tools, etc., for works in progress, and in making inspection trips.

The steamer *Henrietta* was put in commission on the 23d of September, transported stone from Menasha Lock, and sand from Point au Sable to Cedars Lock, and was laid up at Appleton on the 20th of November.

A dwelling for the lock-tender at Eureka was built and completed on the 30th day of November, 1886.

The old crib-locks have as usual required extensive repairs to keep them in working order, and will continue to do so until replaced by new ones.

The following work is required to be done to complete this improvement: To replace the old lower dam at Appleton by a new one; to complete the excavation of a 6-foot channel in Menasha River; to complete the widening of the Neenah outlet of Lake Winnebago; to replace the old dam near Eureka Lock by a new one; to deepen the river channel to 6 feet at low water; to strengthen and pave the canal banks, and to build dwellings for lock-tenders.

Respectfully submitted.

C. A. FULLER,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION APPLIED TO FOX AND WISCONSIN RIVERS, WISCONSIN; SECTION 4, RIVER AND HARBOR ACT JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1887, with itemized statement of expenses attached, as required by above act of July 5, 1884.

Repairs of Montello Levee:		
Labor	$97.75	
Materials	12.85	
		$110.60
Repairs of canal banks, White River Lock, labor		55.50
Repairs of Grand River lock-gates:		
Labor	443.62	
Materials, supplies, and transportation	892.45	
		1,336.07
Repairs of Eureka Lock:		
Labor	435.60	
Materials, supplies, and transportation	279.48	
		715.08
Repairs of Eureka Dam:		
Labor	211.67	
Materials, supplies, and transportation	406.90	
		618.57
Repairs of locks, Upper Fox:		
Labor	261.95	
Materials, supplies, and transportation	932.53	
		1,194.48

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Repairs of dams, Upper Fox, labor, supplies, and transportation		$1,982.24
Dredging bars, Upper Fox, labor, fuel, repairs, and supplies, with dredges and tug		7,162.65
Miscellaneous, steamer *Dekorra*, etc., inspection trip, Upper Fox		66.90
Repairs of Appleton second lock:		
Labor	$1,034.54	
Materials, supplies, and transportation	627.20	
		1,661.74
Repairs of Appleton fourth lock, labor		4.50
Repairs of Appleton upper dam, rubber packing for sluice-gates		2.75
Repairs of Little Chute combined locks, labor		13.00
Repairs of Kaukauna fifth lock, dredging		8.50
Repairs of Kaukauna locks:		
Labor	75.50	
Lumber and nails	6.63	
		82.13
Repairs of Rapid Croche Dam:		
Labor	4,177.17	
Materials, supplies, and transportation	3,182.04	
		7,359.21
Repairs of Little Kaukauna Dam, labor		30.00
Repairs of De Pere Lock:		
Labor	5,824.38	
Materials, supplies, and transportation	3,961.82	
		9,786.20
Repairs of Appleton third lock, labor		41.56
Repairs of Kaukauna fourth lock, labor		9.00
Repairs of canal banks at Cedars, labor		29.50
Dredging bars, Lower Fox, labor		279.38
Care of property and works:		
Materials, supplies, and transportation	186.03	
Watchmen's services and labor	910.88	
		1,096.91
Lock-tenders' services		4,345.27
Gauge-keepers' services		136.66
Overseers' services and traveling expenses		576.51
Salaries of assistant engineers, clerks, etc		3,160.00
Office rent, Milwaukee		140.00
Stationery		39.30
Mileage of officers		17.44
Total		42,061.65

Itemized statement of expenses made from appropriation for operating and care of canals, and other works of navigation, indefinite, act of July 5, 1884, applied to for river Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1886.				
July 2	1	C. A. Fuller	Traveling expenses	$30.15
6	2	Hired men	Services, June, 1886	807.98
6	3	Samuel Whitney	Traveling expenses	20.15
6	4	Charles M. Cole	do	11.20
13	5	William Dobenstein	Services	3.00
13	6	Charles Sims	do	3.00
13	7	Alice Fuller	do	2.50
16	8	E. S. Purdy	Paint, etc	3.70
16	9	Charles S. Morris	Coal	25.26
16	10	Niels Johnson	Packing, etc	8.95
16	11	A. Sanford Manufacturing Company	Peavies	3.35
16	12	O. A. Matthews, treasurer	Mattresses, etc	48.67
16	13	G. D. Norris & Co	Rope	87.75
16	14	Schlafer, Barrett & Tesch	Sledges, etc	39.91
16	15	W. J. McLaughlin	Nails, etc	1.20
16	16	Matteson & Timann	Labor	1.10
21	17	Hired men	Services, July, 1886	283.40
21	18	James Smith	Wood	54.00

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Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1886.				
July 23	19	J. E. Wells & Co	Steel, etc	$7.17
23	20	Charles S. Morris	Wood	7.00
27	21	William Bannerman	Stone	220.00
27	22	J. C. Smith	Wood	38.00
28	23	N. H. Wood	....do	14.00
31	24	Van Dusen & Co	Coal	22.54
31	25	C. A Fuller	Services	200.00
31	26	William Edwards	....do	35.00
31	27	John Lewis	....do	30.00
31	28	Gottlieb Jahnke	....do	30.00
31	29	Gabriel Wick	....do	30.00
31	30	John A. Banker	....do	30.00
31	31	Alexander Sims	....do	30.00
31	32	John M. Paige	....do	35.00
31	33	Andrew O'Connell	....do	10.00
31	34	Chas. S. Morris	Coal	70.55
31	35	Jerry Parkinson	Services	30.00
31	36	George Gifford	....do	30.00
31	37	Richard E. Rice	....do	16.00
Aug. 3	1	Hired men	Services, July, 1886	2,342.38
4				
3	2	C. A. Fuller	Traveling expenses	24.50
3	5	Samuel Whitney	....do	8.70
9	4	C. L. Neuman	Services	10.00
12	5	Frank Wright	....do	10.50
14	6	C. A. Fuller	Traveling expenses	9.55
16	7	Fred Gifford	Services	6.62
17	8	Niels Johnson	Iron, etc	78.11
17	9	H. Stedman	Lumber, etc	84.11
17	10	H. S. Sacket	Oil, etc	79.47
17	11	H. G. Talbot	Lumber, etc	82.10
17	12	Albert Sanford, treasurer	Pike-poles, etc	8.60
17	13	McKenzie & Crawford	Coal	129.20
17	14	Ramsay & Jones	Lumber	451.45
17	15	Schlafer, Barrett & Tesch	Spikes, etc	44.50
17	16	Valley Iron Works	Bolts	30.24
17	17	Appleton Machine Company	Bolts	12.76
17	18	John Schlosser	Toweling, etc	8.85
17	19	Simons & Tuttle	Steel, etc	7.50
17	20	J. B. Kalvelage, treasurer	Inspirator, etc	28.05
17	21	F. W. Zanto	Wood	51.25
17	22	Morgan & Bassett	Iron	176.00
17	23	Jas. N. Warrington, treasurer	Shaft	15.71
18	24	Rollin Gifford	Services	10.60
23	25	G. P. Williams, treasurer	Stationery	23.00
30	26	Aug. Swanke	Wood	33.00
30	27	Chas. S. Morris	Coal	41.74
30	28	H. G. Talbot	Plank	15.65
30	29	J. R. Brown	Oil	4.20
30	30	H. K. Priest	Stone	36.75
30	31	C. A. Peck	Rope, etc	33.30
27	32	Edward T. Frank	Cotton waste, etc	9.62
31	33	Hired men	Services, August, 1886	380.00
31	34	C. A. Fuller	Services	200.00
31	35	William Edwards	....do	35.00
31	36	Richard E. Rice	....do	16.00
31	37	John Lewis	....do	30.00
31	38	Jerry Parkinson	....do	30.00
31	39	Gottlieb Jahnke	....do	30.00
31	40	Frank Wick	....do	30.00
31	41	John A. Banker	....do	30.00
31	42	George Gifford	....do	30.00
31	43	Alexander Sims	....do	30.00
31	44	John M. Paige	....do	35.00
31	45	Andrew O'Connell	....do	10.00
31	46	Fred. Arndt	Wood, etc	49.62
31	47	H. K. Priest	Wood	13.75
31	48	Edward T. Frank	Lumber, etc	4.40
Sept. 9	1	F. T. Yahr	Bolts, etc	2.14
14	2	Edward Briga	Services	19.50
15	3	Ferdinand Writz	Wood	45.00
15	4	H. Stedman	Wood, etc	195.78
15	5	P. B. Yates	Steel, iron, etc	115.42
15	6	T. W. Hamilton	Timber	22.89
15	7	Niels Johnson	Boiler-plate, etc	49.50
15	8	....do	Labor	24.00
15	9	H. S. Sacket	Oil, paint, etc	7.07
15	10	Chas. S. Morris	Wood	7.00

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Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1886.				
Sept. 15	11	Wisconsin Granite Company	Stone	$66.00
15	12	Albert Sanford, treasurer	Oars, etc	3.25
15	13	Ramsay & Jones	Lumber	636.94
15	14	Appleton Machine Company	Drift-bolts	62.15
15	15	Morgan & Bassett	Miter-gear, etc	10.67
15	16	Schlafer, Barrett & Tesch	Nails	3.25
15	17	John Schlosser	Lamp, etc	6.33
15	18	Jacob Kettenhofen	Labor	4.00
15	19	Barney Garrity	Hay	10.00
15	20	Louis Clairmont	Transportation	110.25
15	21	David M. Burns	Iron, etc	77.91
15	22	G. D. Norris & Co	Rope	31.98
15	23	W. F. Viel & Co	Lumber, etc	4.36
15	24	J. S. Pahl	Wood	24.75
15	25	C. A. Fuller	Traveling expenses	14.65
4	26	Hired men	Services, August, 1886	2,250.05
15	27	Gottlieb Luedtke	Iron, etc	4.50
27	28	H. K. Priest	Wood	62.50
30	29	Cramer, Aikens & Cramer	Rent of office	70.00
30	30	C. A. Fuller	Services	200.00
30	31	William Edwards	....do	25.00
30	32	Richard E. Rice	....do	16.00
30	33	John Lewis	....do	30.00
30	34	Jerry Parkinson	....de	30.00
30	35	Gottlieb Jahnke	....do	30.00
30	36	Frank Wick	....do	30.00
30	37	John A. Banker	....do	30.00
30	38	Alexander Sims	....do	30.00
30	39	John M. Paige	....do	35.00
30	40	Andrew O'Connell	....do	10.00
Oct. 2	1	C. A. Fuller	Traveling expenses	7.75
2	2	Levi Gerrardin	Services	1.87
5	3	Hired men	Services, September, 1886	2,826.51
14	4	H. K. Priest	Stone	13.12
14	5	F. T. Yahr	Lime, etc	4.81
14	6	J. S. Pahl	Wood	28.87
14	7	Edward T. Frank	Oil, etc	48.86
14	8	August Swanke	Wood	62.50
14	9	H. Stedman	Wood, etc	111.08
14	10	C. A. Peck	Iron, etc	16.82
14	11	Niels Johnson	Castings, etc	11.67
14	12	....do	Iron pipe, etc	46.35
14	13	Chas. S. Morris	Coal	62.62
14	14	....do	Wood	28.12
14	15	H. S. Sacket	Hay, etc	22.30
14	16	....do	Rope, etc	103.81
14	17	Battis Bros	Iron, bolts, etc	43.65
14	18	Jas. Gillingham & Son	Wheelbarrows	37.72
14	19	Ramsay & Jones	Lumber	555.36
14	20	Appleton Machine Company	Bolts, etc	20.46
14	21	John Schloeser	Nails, etc	26.91
14	22	Morgan & Bassett	Bolts	7.74
14	23	H. Pierce	Oil-cup, etc	1.65
14	24	Simons & Tuttle	Iron, etc	9.55
14	25	Jacob Kettenhofen	Drills, etc	7.25
14	26	Barney Garrity	Hay	5.00
14	27	Louis Clairmont	Sand	32.00
14	28	W. W. Wallis	Boots	12.40
14	29	J. B. Kalvelage, treasurer	Nipple, etc	1.40
14	30	Milwaukee Cement Company	Cement	106.25
14	31	J. W. Allerton	Services	4.00
18	32	Patrick Daley	....do	5.55
22	33	Louis Clairmont	Transportation	439.42
31	34	C. A. Fuller	Services	200.00
31	35	Samuel Whitney	....do	85.00
31	36	Richard E. Rice	....do	16.00
31	37	John Lewis	....do	30.00
31	38	Jerry Parkinson	....do	30.00
31	39	Gottlieb Jahnke	....do	30.00
31	40	John A. Banker	....do	30.00
31	41	Alexander Sims	....do	30.00
31	42	Andrew O'Connell	....do	10.00
31	43	William Edwards	....do	35.00
Nov. 3	1	Caspar Thom	....do	3.00
3	2	C. A. Fuller	Traveling expenses	37.19
4	3	Hired men	Services, October, 1886	3,028.80
3	4	John Murphy	Wood	18.00
3	5	James McGee	....do	11.25

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Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1886.				
Nov. 8	6	Robert H. Crosby	Wood	$15.75
8	7	Theodore Brushman	....do	28.12
8	8	Mueller Bros	Paint, etc	3.65
8	9	F. T. Yahr	Iron, etc	4.84
8	10	Gottlieb Luedtke	Labor	2.00
8	11	Van Dusen & Co	Coal	8.33
8	12	C. A. Peck	Oil, soap, etc	8.10
8	13	Charles S. Norris	Coal	48.30
8	14	Wisconsin Granite Company	Stone	32.00
8	15	Edw. P. Allis & Co	Pinion	20.00
8	16	C. A. Berthelet	Cement	3.35
8	17	G. D. Norris & Co	Blocks	24.75
8	18	H. S. Sacket	Rope, etc	27.13
8	19	Reese & Whiting	Blankets	12.50
8	20	Berlin Machine Works	Steel, etc	18.58
8	21	Martin George	Wood	89.25
8	22	McKenzie & Crawford	Transportation	5.87
8	23	Morgan & Bassett	Iron castings, etc	14.25
8	24	Schlafer, Barrett & Tesch	Spikes	13.95
3	25	John Schlosser	Nails, etc	5.71
8	26	Ramsay & Jones	Plank	51.84
8	27	H. A. Foster	Oil	2.40
8	28	Elisa Thoermer	Wood	23.70
8	29	H. Collette	Lumber	363.00
8	30	A. Kimball	Nails	69.00
8	31	J. R. Brown	White lead	.95
10	32	Henry Shuh	Services	6.75
10	33	Jacob Kettenhofen	....do	2.00
10	34	D. J. Ferguson	....do	3.50
10	35	Loyal W. Fuller	....do	41.47
12	36	Desire Copperamith	....do	10.00
15	37	Moses Girdan	....do	8.75
15	38	Michael Bocokske	Wood	35.00
27	39	Oswolt Hinickle	Services	22.50
30	40	C. A. Fuller	....do	200.00
30	41	William Edwards	....do	35.00
30	42	Richard E. Rice	....do	16.00
30	43	John Lewis	....do	30.00
30	44	Jerry Parkinson	....do	30.00
30	45	Gottlieb Jahnke	....do	30.00
30	46	Gabriel Wick	....do	50.00
30	47	John A. Banker	....do	30.00
30	48	George Gifford	....do	28.33
30	49	Friedrich A. Thoermer	....do	22.00
30	50	Alexander Sims	....do	22.00
30	51	Bailey Grover	....do	5.00
30	52	Andrew O'Connell	....do	6.66
30	53	Hired men	Services, November, 1886	544.33
Dec. 6	1	....do	....do	1,352.24
6	2	Charles D. Winn	Services	4.50
8	3	C. A. Peck	Oil	.90
8	4	Chas. S. Morris	Coal	44.57
8	5	Martin George	Wood	98.06
8	6	Geo. Challoner's Sons	Labor	14.00
8	7	McKenzie & Crawford	Coal	33.75
8	8	Paine Lumber Company	Wood	10.00
8	9	Ramsay & Jones	Lumber	80.64
8	10	Schlafer, Barrett & Tesch	Wheelbarrows, etc	31.05
8	11	W. E. Harbridge	Clay	24.48
8	12	A. G. Wells & Co	Nails, etc	4.72
8	13	George Lamare	Clay	23.20
8	14	Louis Clairmont	Wood, etc	120.46
8	15	Max Scheuring	Hay	7.00
8	16	H. Collette	Lumber, etc	83.37
8	17	W. W. Le Fever	Towing	10.00
8	18	F. T. Yahr	Lime and wheelbarrows	14.55
8	19	Charles M. Cole	Traveling expenses	2.76
8	20	C. A. Fuller	....do	29.68
8	21	C. L. Neuman	Services	10.00
16	22	Jacob Kettenhofen	....do	3.50
21	23	Julia M. Parker	Towing	18.00
22	24	Louis A. Smith	Services	5.00
22	25	....do	Traveling expenses	3.00
31	26	C. A. Fuller	Services	200.00
31	27	William Edwards	....do	35.00
31	28	John A. Banker	....do	30.00
31	29	Bailey Grover	....do	25.00
31	30	George Gifford	....do	25.00

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Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1886.				
Dec. 31	31	John Linden	Services	$25.00
31	32	John Kilawee	....do	15.00
31	33	Edgar Challenger	....do	12.62
1887.				
Jan. 4	1	Hired men	Services, December, 1886	1,453.65
4	2	C. A. Fuller	Traveling expenses	31.10
5	3	H. S. Sacket	Oil, etc	7.87
5	4	August Niber	Wood	30.00
5	5	Martin George	....do	45.00
5	6	John Schlosser	Spikes, etc	76.90
5	7	Marie Hansaer	Powder	30.50
5	8	H. H. Greene	Exploders	6.43
5	9	J. & M. Rosemeissl	Boots	8.00
5	10	A. G. Wells & Co	Oil, etc	5.75
5	11	C. A. Lawton	Clay, etc	6.41
5	12	Steinfeldt, Adams & Co	Wood rollers	2.50
5	13	F. W. Zantoo	Wood	13.75
8	14	Frank Clarken	Services	2.27
10	15	John Flynn	....do	14.00
31	16	C. A. Fuller	....do	200.00
31	17	John A. Banker	....do	30.00
31	18	Bailey Grover	....do	25.00
31	19	George Gifford	....do	25.00
31	20	John Kilawee	....do	15.00
31	21	Hired men	Services, January, 1887	380.00
31	22	William Edwards	Services	35.00
Feb. 2	1	Hy Bergman	Powder, etc	70.58
2	2	John Schlosser	Rope	4.86
2	3	A. G. Wells & Co	Oil, etc	5.65
2	4	N. S. Wight	Lumber	658.63
2	5	Edward P. Allis & Co	Pinion	14.00
3	6	Hired men	Services, January 1887	1,425.02
3	7	C. A. Fuller	Traveling expenses	6.38
3	8	Robert Herman	....do	4.97
28	9	Samuel Whitney	....do	26.10
28	10	C. A. Fuller	Services	200.00
28	11	William Edwards	....do	35.00
28	12	John A. Banker	....do	30.00
28	13	Bailey Grover	....do	25.00
28	14	George Gifford	....do	25.00
28	15	John Kilawee	....do	15.00
28	16	Samuel Whitney	Traveling expenses	18.20
28	17	C. A. Fuller	....do	8.73
Mar. 3	1	Hired men	Services, February, 1887	1,388.41
4	2	Schlafer, Barrett & Tesch	Iron, etc	58.44
4	3	Ramsay & Jones	Lumber	87.24
4	4	C. A. Lawton	Bolts	18.40
4	5	Winegard and Persons Company	Wood	60.00
3	6	Milwaukee and Northern Railroad	Freight charges	13.74
25	7	Hired men	Services, March, 1887	97.75
29	8	Patrick Croarken	Manure, etc	12.85
31	9	C. A. Fuller	Services	200.00
31	10	William Edwards	....do	35.00
31	11	John Kilawee	....do	15.00
Apr. 1	1	C. A. Fuller	Traveling expenses	20.77
4	2	Chicago, Milwaukee and St. Paul Railroad.	Freight charges	30.16
4	3	Hired men	Services, March, 1887	1,956.52
4	4	C. A. Berthelet	Cement	18.08
4	5	August Ziemer	Lumber	19.10
4	6	H. S. Sacket	Nails, etc	23.45
4	7	Ramsay & Jones	Lumber	5.20
4	8	Morgan & Bassett	Suspension gears	41.24
4	9	Valley Iron Works	Castings, etc	122.31
4	10	John Schlosser	Wheelbarrows, etc	17.10
4	11	C. De Johnghe	Sand	4.50
4	12	C. A. Lawton	Bolts	12.75
4	13	N. S. Wight	Lumber	35.85
4	14	H. Collette	....do	34.50
4	15	....do	Lumber, etc	902.27
4	16	Thomas Jackson	Bolts, etc	18.30
4	17	Gerry Lumber Company	Lumber	33.36
6	18	Samuel Whitney	Traveling expenses	1.75
30	19	Hired men	Services	74.32
30	20	Samuel Whitney	Traveling expenses	5.55
30	21	....do	Services	150.00
30	22	C. A. Fuller	....do	200.00
30	23	William Edwards	....do	35.00

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Itemized statement of expenses, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1887.				
Apr. 30	24	James Clear	Services	$35.00
30	25	John Lewis	....do	13.00
30	26	Jerry Parkinson	....do	13.00
30	27	Gottlieb Jahnke	....do	13.00
30	28	Lieut. Graham D. Fitch	Mileage	17.44
30	29	Gabriel Wick	Services	13.00
May 2	1	C. A. Fuller	Traveling expenses	24.13
4	2	Hired men	Services, April, 1887	1,167.97
4	3	Richard E. Rice	Services	8.00
9	4	Hatch & Keith	Lumber	1,238.04
9	5	Des Forges & Co.	Stationery	23.89
10	6	Riley Bemis	Services	2.85
16	7	Charles M. Cole	Traveling expenses	9.59
19	8	C. A. Fuller	....do	10.45
26	9	Hired men	Services	169.01
31	10	C. A. Fuller	....do	200.00
31	11	William Edwards	....do	35.00
31	12	James Clear	....do	35.00
31	13	Richard E. Rice	....do	16.00
31	14	Gottlieb Jahnke	....do	30.00
31	15	Gabriel Wick	....do	30.00
31	16	John M. Paige	....do	29.16
31	17	Jerry Parkinson	....do	30.00
31	18	Friedrich A. Thoermer	....do	25.00
31	19	Alexander Sims	....do	25.00
31	20	John Lewis	....do	30.00
31	21	J. C. Mitchell	Lumber, etc	6.63
31	23	H. Stedman	Lumber	27.96
31	23	Tiney Smith	Hire of capstan	2.00
31	24	C. A. Peck	Rope, etc	17.15
31	25	Priest & Garrow	Transportation	28.06
31	26	Morgan & Bassett	Casting, etc	397.81
31	27	Valley Iron Works	Castings	81.82
31	28	Ramsay & Jones	Lumber	125.81
31	29	Schlafer, Barrett & Tesch	Spikes, etc	25.25
31	30	Charles Cavert	Gravel	15.00
31	31	Winegard & Persons Company	Oil	6.38
31	22	C. A. Fuller	Traveling expenses	15.93
June 2	1	Adolph Meisler	Services	5.55
3	2	Carl Sager	....do	1.25
6	3	Hired men	Services, May, 1887	1,178.76
7	4	Des Forges & Co	Stationery	16.30
7	5	Niels Johnson	Lumber, etc	44.80
7	6	H. S. Sacket	Barbed wire, etc	8.79
7	7	Morgan & Bassett	Chain, bolts, etc	223.75
7	8	J. H. Marston & Co	Cement	1.00
7	9	Gerry Lumber Company	Lumber	12.24
7	10	F. H. Blood	Coal	35.47
7	11	H. I. Wheeler	Paint, etc	3.32
7	12	Green Bay Dredge and Pile-Driver Company.	Dredging	105.00
7	13	L. G. Schiller	Towing	18.00
14	14	D. J. Ferguson	Services	1.50
14	15	Theodore West	....do	8.75
14	16	Timothy Garvey	....do	1.25
20	17	Michael Midvill	....do	3.12
27	18	W. D. Freeman and Richard Flood	Brick, etc	57.33
30	19	Cramer, Aikens & Cramer	Rent of office	70.00
30	20	C. A. Fuller	Services	200.00
30	21	Andrew O'Connell	....do	10.00
30	22	William Edwards	....do	35.00
30	23	James Clear	....do	35.00
30	24	John Lewis	....do	30.00
30	25	Jerry Parkinson	....do	30.00
30	26	John M. Paige	....do	35.00
30	27	Frederich A. Thoermer	....do	30.00
30	28	Richard E. Rice	....do	16.00
30	29	C. A. Fuller	Traveling expenses	13.58
		Total		42,061.65

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SURVEY OF WISCONSIN RIVER.

REPORT OF THE BOARD OF ENGINEERS.

OFFICE OF THE BOARD OF ENGINEERS FOR FORTIFICATIONS AND FOR RIVER AND HARBOR IMPROVEMENTS,
New York, December 14, 1886.

GENERAL: The Board of Engineers has the honor to submit the following report upon the experiment which has been in progress upon the Wisconsin River since 1880, to determine the practicability of contracting that river sufficiently to give a low-water navigable depth of 4 or 5 feet by means of low brush-dikes and wing-dams in the bed of the stream. This report is in response to the call in the river and harbor act of Congress, approved August 5, 1886, and transmitted to the Board by letter of the Chief of Engineers dated August 12, 1886.

The history of the work upon the Wisconsin is briefly as follows:

Congress, by act approved June 23, 1866, provided for an examination and survey of the river with a view to making it a part of a water communication between the Mississippi and the Great Lakes. The work was assigned to General Warren, and a detailed survey (119 miles) was made in 1867. In his Annual Report for 1867-'68 he indicated that a canal for a part or the whole of the distance along the valley would be the most reliable method of improvement. In his next Annual Report he recommended that $100,000 be appropriated for making wing-dams. His proposed application of the appropriation is given in his report contained in the Report of the Chief of Engineers for 1870, page 226, concluding as follows:

> The next piece of work I would do would be to attempt to make a suitable navigation in the part of the river at the three places where the canal navigation was planned to cross it. The success attending the works at these points would demonstrate the possibility or not of improving the whole river in the same way at a less expense than to make a canal. If there should be a complete failure at these points, it would show not only that the river itself could not be improved, but that the canal proper must be so altered as not to depend on crossing the river.

Congress, by act of July 7, 1870, authorized the Secretary of War to "adopt for the improvement of the navigation of the Wisconsin River such plan as may be recommended by the Chief of the Bureau of Engineers," and on July 11, 1870, appropriated $100,000 "for the improvement of the Wisconsin River."

General Warren's health having failed, the charge of the work was transferred to Colonel Houston. Operations were commenced July 1, 1871, having for their object to determine the practicability of securing by dikes and dams a navigable depth of 5 feet, especially at the proposed canal crossings.

It is not necessary to recapitulate in detail the annual progress of the improvement, which is fully set forth in the reports of the Chief of Engineers. The following extract from Colonel Houston's annual report (Report of the Chief of Engineers for 1880, page 1948) defines in brief its general plan and history:

> The plan thus far pursued has been to improve the natural channel of the river by reducing its width so as to increase the depth by concentrating the force of the current in a narrower channel. The bed of the river being sand, it yields readily to this increased force. The natural channel of the river is divided by numerous islands, and in carrying out the plan the object has been, first, to confine the river to a single channel and then to gradually reduce its width until the required depth should be attained. This system was carried out up to 1875, when, owing to expressions of dissatisfaction as to the results and progress of the work, operations were confined to short sections

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of the river looking to its contraction to the width necessary to produce the required depth. Work was directed to this end during the season of 1875.

In 1876 no appropriation was made until August 14, and the funds available were necessary to carry on the works which had been commenced on the Fox River, and from their character could not be stopped without great loss; consequently work was suspended on the Wisconsin. In 1877 no appropriation was made for rivers and harbors. No work was done on the river in 1876 and 1877. In 1878, after the passage of the appropriation of June 18, work was resumed on the Wisconsin, and has since consisted principally in repairs of dams and protections of the shore from the abrading action of the current.

The total amount of work done on the river up to June 30, 1880, is as follows:

One hundred and fifty-seven dams; total length, 76,684 feet.

Six shore protections; total length, 5,714 feet.

Fifteen hundred and twenty-three snags removed.

Seventy three hundred and thirty-two leaning trees felled.

This work is in two sections: First, from Portage to Prairie du Sac; second, from Lone Rock to Boscobel, a total distance of 50 miles.

In 1879 the subject of the improvement of the Wisconsin River was referred to the Board of Engineers for report. Its conclusions, after a study of all available data and a personal inspection of the river below Portage, were:

The works for the improvement of the river, although ameliorating the navigable draught wherever these have been applied, have not been sufficiently decisive in results to enable the Board to recommend their application to the whole length of the channel without the aid of further information.

We think, therefore, that the section of the river already partially operated upon, from Portage for a length of about 12 miles, should receive additional wing-dams, and the width of the low-water channel should be contracted to 300 feet.

As this section has a slope somewhat exceeding the average, we think the results will be decisive, and if the channel be improved, for a reasonable amount, to an adequate depth, the application of the same system to the rest of the river could be confidently recommended.

While these works are under construction frequent gaugings should be made to determine the volume passing through the channel at different stages, say at Portage, Dekorra, and Skinner's Bluffs. Also frequent soundings in the deepest part of the channel should be made through the improved section, with such angular measurements as will enable the track followed by the boat to be laid down in each case upon the map. These soundings should be referred to an absolute datum, by benches carefully established.

The estimated cost of the work now proposed is $80,000.

These recommendations were in part carried out, and the subject, with the data obtained, was again referred to the Board in 1883. The following extracts from its report (Report of Chief of Engineers, for 1884, page 1900) convey the more important conclusions reached:

By calculations based upon these observations it appears that the water plane corresponding to the same discharge as when the water stood at zero of Warren's gauge, at Portage in 1867, has been continually falling, so that it stood at the following readings on that guage: In 1879, at $-0'.445$; 1881, at $-0'.87$, and in 1882, at $-1'.0$.

The navigable depth in a section from Portage to Dekorra of 7 miles in length was found after reduction to be 2.83 feet, at a stage of water 1.3 feet in 1882, below the zero of Warren's gauge at Portage.

The increase of navigable depth since 1867, caused by the construction of wing-dams in the same section, is 1.78 feet.

That to obtain a navigable depth of 4 feet at all stages it would appear from calculation to be necessary to contract the river to a width of about 150 feet at Portage, and about 300 feet near the mouth at Bridgeport.

But as the results above were deduced from the observations furnished, which in the opinion of the Board were not sufficient, and their value even was in doubt from having been made during and too soon after the construction of the wing-dams, these results are not considered as sufficiently reliable to determine the utility of the works constructed and proposed.

* * * * * * *

To have insured reliable results, not only should the corresponding low-water levels at Portage and Dekorra with differences of level have been accurately known, but the Board should also have been furnished with observations sufficient to fix the low-water levels and differences of level at intermediate places, so as to have determined

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sufficient points of reference for the reduction of soundings; which precautions for accuracy are of additional importance where the range of improvement is limited and the weight of small errors thereby greatly enhanced.

Observations upon the water volume should preferably be taken at and near the stage corresponding to the discharge at Portage of 2,114 cubic feet, and a survey with soundings sufficient to construct accurate cross-sections should be made at and near the same stage of water.

Whatever may be the practical benefits to navigation of this improvement there is no doubt that the results should be recorded, with the attendant circumstances, for future instruction in like cases.

Approving this report, the Chief of Engineers suspended all work on the Wisconsin, except needed repairs and the making of the observations suggested by the Board.

The season of 1885 was unfavorable to obtaining the desired data, but the past season, being an exceptionally low-water year, has been favorable, and the report now under consideration from Captain Marshall, who succeeded to the charge of the work in 1884, affords sufficient data for deciding upon the degree of success of the experiment.

Captain Marshall's report covers the ground so fully and concisely that no further analysis of the data is necessary here. It appears that for the improved section from Portage to Dekorra, a distance of about 7 miles, where the low-water discharge is now confined to a width of 300 feet by wing-dams, (1) that the gradual lowering of the water plane noted during the progress of the works has ceased since their completion in 1882; it now aggregates about nine-tenths of a foot; (2) that the mean depth, corresponding to a discharge at Portage of 3,360 cubic feet per second, is now about 1.8 feet more than in 1867, and about nine-tenths of a foot less than in 1882; (3) that the improved channel is narrow and tortuous, and is subject to continual variation in the number and length of its bars; (4) that the improved channel at the ordinary low-water stage is a succession of pools and rapids with a slope varying from 0.32 feet to 2.82 feet per mile; (5) that a water-surface 2 feet above ordinary low water is required to give a navigable depth of 4 feet on the worst bars throughout the improved section; and that there were 46 days in 1882, 34 days in 1883, 37 days in 1884, 63 days in 1885, and 91 days in 1886 when the river was below that stage; (6) that the annual cost of keeping the dams in repair has averaged $585 per mile of channel since their completion. They still remain in fair condition, but have settled somewhat from the decay and breaking of the brush composing them. Should the whole river from Portage to the Mississippi be improved upon this system, an annual expenditure of about $70,000 would be required for ordinary maintenance, in addition to occasional outlays for renewing crests destroyed by alternate exposure to air and moisture.

These facts, in the judgment of the Board, are decisive against the application of this mode of improvement to the Wisconsin. Its high slope (18 inches per mile) causes velocities too great for control in a navigable channel through its bed of shifting sand.

The data already obtained in this experiment are exceedingly valuable in their bearing upon the improvement of other similar rivers, of which there are many in the United States, and the Board recommends that occasional examinations of the improved section be made to detect future changes; but that no more money be expended upon dikes and wing-dams in the bed of the Wisconsin River. If a navigable route carrying 4 or 5 feet of water from Portage to the Mississippi is still required by the needs of commerce, recourse must be had to a canal. General Warren's estimate (made eleven years ago) for a 4-foot navigation was $4,000,000, and for 5-foot navigation $4,165,000 with an annual cost of maintenance of $50,000.

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As to the practical importance of a through route by way of the Fox and Wisconsin rivers, great changes have occurred during the past twenty years. Railroads have multiplied, and by sharp competition between themselves may maintain rates at so low figures that it is very doubtful if an ordinary canal can compete with them so as to materially reduce rates over a route so unfavorable as that from Green Bay to the Mississippi. This change in the practical importance of the problem can not be ignored, and the Board would refer to Colonel Houston's discussion in his report of October 16, 1883 (report to the Chief of Engineers for 1884, page 1925), and to Captain Marshall's remarks in his present report. The Board concurs with these officers in the view therein expressed. At any rate, action should be delayed until the limit of practical improvement in the low-water navigation of the Mississippi from Saint Paul downward has been determined. That limit will fix the depth demanded in a canal traversing the valley of the Wisconsin.

The papers referred to the Board in this connection are herewith returned.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen.
C. B. COMSTOCK,
Lieut. Col. of Engineers and Bvt. Brig. Gen.
D. C. HOUSTON,
Lieut. Col. of Engineers.
WALTER MCFARLAND,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

REPORT OF CAPTAIN W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 17, 1886.

SIR: I have the honor to submit the following memoir upon the results of the observations taken upon the Wisconsin River in 1885 and 1886, as required by the Board of Engineers for Fortifications and River and Harbor Improvements:

The observations consisted of discharge observations at Portage; below mouth of Baraboo River; at Rocky Run, and at Dekorra, Wis.; gauge-readings at the same stations, and longitudinal and sectional soundings at about the lowest stages reached by the river. The discharge observations at the three lower stations, in 1885, as stated in my letter transmitting the observations and computations, are evidently unreliable, on account of the defective sections taken at these points. In 1886 the observations were satisfactory at all the stations, and were secured at the low-water stage, except at Rocky Run, which gauging station was omitted in 1886.

The discharges were measured with rod-floats 2½ inches in diameter, loaded to maintain a vertical position; with double floats; and with a new Price's current meter properly rated, run at mid-depth. The mid-depth observations were reduced by the method given in Professional

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Papers, Corps of Engineers, No. 12. The rod-float observations were reduced by Francis' formula.

For the purpose of comparison with the results given in the report of the Board of Engineers for Fortifications, January 5, 1884, published in the Report of the Chief of Engineers for 1884, pages 1900–1917, the observations at Portage and the channel soundings have been taken and reduced in the manner indicated in that report, and the results tabulated herein, from which the changes in the regimen of the river since 1882 may be deduced by the Board.

The observations taken at the stations below Portage even in 1886 were not used in making the reduction for comparison with the former results obtained by the Board, it having been considered better to follow exactly the same treatment in every case. The observations at these stations taken in 1886 at low water are, however, submitted herewith in order that the Board may consider them if thought necessary.

The computations in the tables herewith were made by First Lieut. Graham D. Fitch, Corps of Engineers, under my direction.

Variation in discharge for a rise or fall of one-tenth of a foot at Portage, 1885.

Discharge (means of all observed at each reading).	Reading of gauge.	Differences from mean—		Variation in discharge for one-tenth foot in gauge.	V.	V^2.
		In discharge.	In gauge reading.			
		Cu. feet.	*Feet*			
4641	0.58	680	0.468	145.3	27.3	745.29
4230	0.33	269	0.218	123.4	49.2	2420.64
4233	0.20	272	0.188	144.2	28.4	806.56
3916	0.10	45	0.012	375.05	202.4	40965.76
4052	0.15	91	0.038	239.0	66.4	4408.96
4023	0.20	62	0.088	70.4	102.2	10444.84
3989	0.12	28	0.008	350.05	177.4	21470.76
3827	0.00	134	0.112	119.0	53.0	2809.00
3812	0.03	144	0.082	181.7	9.1	82.81
3786	0.00	175	0.112	156.2	16.4	268.96
3719	−0.07	242	0.182	132.9	39.7	1576.09
3592	−0.10	369	0.212	174.0	1.4	1.96
3821	−0.05	140	0.162	86.4	86.2	7430.44
3806	−0.02	155	0.132	148.2	54.4	2959.36
Sum.....	55447	1.57		2410.8		13)106391.43
Mean.....	3961	0.112		172.6 (1)		e^2= 8183.96
						k^2= 4.173
	55447	1.57		2410.3		e^2k^2=34151.0651
	−3916	−.10		−375.0		ek= 184.801
	−3989	−.12		−350.0 (2)		
	12)47542	12)1.35		12)1691.3		e^2= 8183.96
	3961.8	.113		140.3 c. ft.		k^2= 3.073
						e^2k^2= 14797.3983
						ek= 157.47

The application of Peirce's criterion as above rejects the fourth and seventh observations, and there results from the above observations 140.3 cubic feet per second as the variation in discharge for a rise or fall of one-tenth of a foot, and we also see that a discharge of 3,961.8 cubic feet per second corresponds to a reading of 0.113 foot on the Portage gauge.

The discharge at a reading of zero on the Portage gauge is, therefore, 3,961′.8−(140′.3×1′.13)=3,803.3 cubic feet.

Since, however, the zero of the gauge at Portage is 0.318 foot above the zero of Warren's gauge, the discharge in 1885 at the zero of Warren's gauge was 3,803.3 cubic feet −(140′.3×3′.18)=3,357.1 cubic feet per second.

The corresponding discharge in 1867 was 2,114 cubic feet, as estimated by the Board of Engineers, hence the discharge at zero in 1885,

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as compared with 1867, has increased 3,357.1—2,114=1,243 cubic feet per second, or the water plane has been lowered—

$$\frac{1243}{140'.3\times 10}=0'.888.$$

Variations in discharge for a rise or fall of one-tenth of a foot at Portage, 1886.

Discharges, 1886.	Reading of Portage gauge.	Difference from mean—		Variation in discharge for 0.1 rise or fall.	V.	V^2.
		In discharge.	In gauge-reading.			
2849	—0.39	357	0.48	74.4	26.9	723.61
3059	—0.20	567	0.58	97.8	3.5	12.25
3126	—0.13	634	0.65	97.5	3.8	14.44
2912	—0.30	420	0.48	87.5	13.8	190.44
2980	—0.33	488	0.45	108.5	7.2	51.84
2730	—0.47	238	0.31	76.8	24.5	600.25
2706	—0.57	214	0.21	101.9	0.6	0.36
2568	—0.73	76	0.05	152.0	50.7	2570.49
2439	—0.78	53	0.00	0.0	.....	.....
2434	—0.85	58	0.07	82.9	18.4	338.56
2343	—0.89	149	0.11	135.5	34.2	1169.64
2317	—0.90	175	0.12	145.8	44.5	1980.25
2312	—0.94	180	0.16	112.5	11.2	125.44
2316	—0.91	176	0.13	135.4	34.1	1162.81
2315	—0.94	177	0.16	110.6	0.3	86.49
2220	—0.06	272	0.28	97.1	4.2	17.64
2179	—1.16	313	0.38	81.8	19.5	380.25
2165	—1.18	327	0.40	81.8	19.5	380.25
2123	—1.22	369	0.44	83.9	17.4	302.76
2089	—1.29	403	0.51	79.0	22.3	497.29
2146	—1.20	346	0.42	82.4	18.9	357.21
21)52328	21)16.35	.....	.....	20)2025.1	.....	19)10962.27
2492	—0.78	.....	.....	101.3	.....	e^2= 576.96
52328	16.35	.....	.....	.....	.....	k^2= 4.878
—2439	—0.78	.....	.....	.....	.....	e^2k^2=2814.4109
20)49889	20)15.57	.....	.....	.....	.....	ek= 53.05
2494.5	—0.78	.....	.....	.....	.....	.....

Rejecting the ninth observation there results from the above observations 101.3 cubic feet per second as the variation in discharge for a rise or fall of one-tenth of a foot in 1886, and we also see that a discharge of 2,494.5 cubic feet per second corresponds to a reading of —0.78 on the Portage gauge.

The discharge in 1886 at a reading of zero on the Portage gauge is, therefore, 2494.5+(101.3×7.8)=3284.64. Since, however, the zero of the gauge at Portage is 0'.318 above the zero of Warren's gauge, the discharge in 1886 at the zero of Warren's gauge becomes 3,284'.64—(101.3×3.18)=2,962.5 cubic feet per second.

The corresponding discharge in 1867 was 2,114 cubic feet, as estimated by the Board of Engineers; hence the discharge at zero in 1886 as compared with 1867 has increased 2,962.5—2,114=848.5 cubic feet per second, or the water plane has been lowered—

$$\frac{848'.5}{101'.3\times 10}=0'.837.$$

The lowering of the water plane below Warren's zero of 1867, as determined by the Board of Engineers, was 0.445 foot in 1879; 0.61 foot in 1880; 0.87 foot in 1881, and 1.0 foot in 1882.

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These figures should be reduced 0.118 foot, due to an erroneously taken level for the zero of the present gauge, which is 0.318 foot above Warren's zero instead of 0.2 foot, as taken by the Board.

Applying this correction to the determinations of 1882 gives for that year's zero —0.882 foot. In 1885 the zero was —0.888 foot, and in 1886 —0.837 foot, showing that there has been no further lowering of the low-water plane since 1882.

Warren's gauge in 1867, when the discharge was 3,360 cubic feet per second, stood at 0.6 foot. In 1885 for a discharge of 3,360 cubic feet per second the reading on Warren's gauge would be—

$$\frac{3360'.-3357'.1}{140'.3\times 10}=0'.002.$$

Soundings were taken in 1885 at a reading —0.1 foot on the Portage gauge, or 0.218 foot on Warren's gauge; hence the correction to be applied to the soundings in 1885 to reduce them to discharge of 3,360 cubic feet per second is $-0'.218+.002=-0'.216$. In 1886 for a discharge of 3.360 cubic feet per second the reading on Warren's gauge would be—

$$\frac{3360-2962'.}{101'.3\times 10}=0'.39.$$

Soundings were taken in 1886 at a reading of —1.21 feet on the Portage gauge, or —0.892 foot on Warren's gauge; hence the correction to be applied to the soundings in 1886 to reduce them to a discharge of 3,360 cubic feet per second is $0'.39+0'.892=+1'.282$.

Applying the corrections above determined, viz, —.216 to the 1885 soundings, and +1.282 feet to the 1886 soundings, in the best channel from Portage to a point 4 miles below, and placing the results in the table already published in the last report of the Board of Engineers, we obtain the following comparative results:

TABLE OF MEAN DEPTHS, AT A DISCHARGE OF 3,360 CUBIC FEET PER SECOND AT PORTAGE.

	Feet.
Warren's survey, 1867	4.22
Houston's survey:	
August 25, 1881	6.52
August 25, 1882	6.89
September 22, 1882	6.96
Marshall's survey:	
October 15, 1885	6.093
August 10, 1886	6.077

Showing a diminution of mean depth in 1885 and 1886 over 1882 of about 0.9 foot, and an increase over 1867 of *about* 1.8 foot in mean depth.

Lengths and depths of pools and bars, at a discharge of 3,360 cubic feet per second at Portage, from Portage to a point 4 miles below.

	Pools.		Bars.		
	Length.	Depth.	Length.	Depth.	Number.
Warren's survey, 1867	7,390	6.08	15,410	3.63	14
Houston's survey:					
August, 1881	19,400	6.89	3,280	4.319	14
August, 1882	20,585	7.11	1,785	4.377	8
September, 1882	20,460	7.218	2,200	4.624	11
Marshall's survey:					
October, 1885	10,370	6.588	4,730	4.409	17
August, 1886	18,860	6.268	2,960	4.484	8

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The calculations of mean depths was made by adding the products in each case of the lengths of the corresponding bars and pools by the respective depths, and dividing by the sum of the lengths of the bars and pools.

The terms "bars" and "pools" correspond to depths, respectively, greater and less than 5 feet.

DEPTHS AVAILABLE FOR NAVIGATION.

To the results given in the last report of the Board of Engineers, I have added the soundings given by the surveys of October, 1885, and August, 1886, for a distance of 30,100 feet from Portage toward Dekorra, using the same method of reducing to what the Board terms *ordinary low water*, as indicated in their report. This stage, however, corresponding to 2,114 cubic feet discharge, is but seldom reached, or is not *ordinary* low-water stage. During the season of 1886, however, due to a prolonged drought, the river attained a slightly lower stage than this, and this low stage, therefore, should be considered.

Table of mean soundings upon bars, reduced to ordinary low water.

	Warren, 1867.	Houston.						Marshall.	
		Aug. 23, 1881.	June 23, 1882.	Aug. 28, 1882.	Sept. 22, 1882.	Nov. 6, 1882.	Sept. 14, 1883.	Oct. 15, 1885.	Aug. 10, 1886.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Mean of sounding less than 4 feet	2.762	3.13	2.854	3.356	3.54	3.043	3.51	3.45	3.37
Least sounding	1.4	2.13	0.5	2.7	3.15	1.65	2.65	2.5	2.21
Reading on Warren's gauge	0.7	0.1	2.5	0.4	−0.15	2.45	0.05	0.218	−0.892
Calculated reading, Warren's gauge of low-water plane	0.0	−0.87	−1.0	−1.0	−1.0	−1.0	−1.1	−0.888	−0.837
Reduction to ordinary low water	0.7	0.97	3.5	1.4	0.85	3.45	1.15	1.106	−0.055

From Portage to Dekorra, 6 miles.

	Number of bars.	Length of bars.
Warren, 1867	20	17,530
Houston:		
August 23, 1881	24	6,570
June 23, 1882	24	12,930
August 28, 1882	16	3,720
September 22, 1882	21	4,100
November 6, 1882	25	6,640
September 14, 1883	28	4,980
Marshall:		
October 15, 1885	37	8,135
August, 1886	15	3,610

From the above table it may be seen that since August, 1881, both the number of bars and their length have increased in 1885. The effect of increasing the number of alternate contractions and expansions in width by the addition of wing-dams not continuous, is to increase the *number* of bars and pools; to diminish the depths of pools and, if the dams are sufficiently numerous, either to increase the depth on bars or to lower the water plane, or both.

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In 1886 the cause of the apparent diminution in lengths and number of bars is evident by looking at the maps of the surveys. The bars are not at ordinary stages reduced in number, but as the water declines these dams have been cut through at the points of least resistance, furnishing an apparent channel-way, very narrow and tortuous, almost impossible for a boat to follow. The improvement, therefore, in the comparative number and lengths of bars in 1886 over 1885 is only an apparent and not a real one. These elements are now about the same as shown by the survey of August, 1882.

The continual variation in the number and lengths of bars is a bad feature of the river, regarded as a channel for navigation, showing the instability of its channel and regimen, due the shifting sand-bars. The channel can never reach a position of even approximately stable equilibrium as long as there are moving sands and alterations in width of channel.

The calculations for finding the comparative mean depths of the river, corrected for filling, in 1885 and in 1886 have been made, and the results added to the table on page 1910 of the last report of the Board of Engineers, with the results shown in the last column of the table below:

Table of corrected mean depths at ordinary low water, and at 0.3 below this stage.

	Date of survey.								
	1867.	Aug. 25, 1881.	June 23, 1882.	Aug. 28, 1882.	Sept. 22, 1882.	Nov. 6, 1882.	Sept. 14, 1883.	Oct. 15, 1885.	Aug. 10, 1886.
Gauge reading (Warren's)	0.7	0.1	2.5	0.4	−0.15	2.45	0.05	0.218	−0.892
Gauge readings, ordinary low water	0.0	−0.87	−1.0	−1.0	−1.0	−1.0	−1.0	−0.688	−0.837
Mean at actual soundings	3.462	4.1 3.462	0.354 3.462	4.756 3.462	4.89 3.462	6.493 3.462	4.66 3.462	4.548 3.462	3.26 3.462
Rise of water above 1867.	.....	0.638 .270	2.892 2.890	1.294 0.700	0.928 0.150	3.031 2.750	1.198 0.450	1.186 0.406	−0.102 −0.755
Increase of depth since 1887	.....	0.368	0.092	0.594	0.778	0.281	0.748	0.680	0.653
Correction for filling	0.00	0.050	0.5208	0.1302	0.0279	0.5115	0.083	0.074	−0.139
	0.00 3.462	0.418 3.462	0.6128 3.462	0.7242 3.462	0.8059 3.462	0.7925 3.462	0.831 3.462	0.754 3.462	0.514 3.462
Corrected	3.462 0.7	3.880 0.7	4.0748 0.7	4.1862 0.7	4.2679 0.7	4.2545 0.7	4.293 0.7	4.216 0.7	3.976 0.7
Mean at ordinary low water	2.762 0.3	3.180 0.3	3.3748 0.3	3.4862 0.3	3.5679 0.3	3.5545 0.3	3.5933 0.3	3.516 0.3	3.276 0.3
Mean depth at 0.3 below ordinary low water	2.46	2.88	3.075	3.186	3.27	3.25	3.29	3.216	2.976

Which, instead of an improvement in the mean depths since the last report, shows rather a deterioration in depth of about 0.3 foot, and an improvement over the unimproved river as shown by Warren's survey of about 0.5 foot.

In passing from the actual soundings which were made in 1886 at a stage 0.055 foot below the ordinary low water, *i. e.*, 2,114 cubic feet a second, discharge stage, to a stage of water corresponding to a discharge of 3,360 cubic feet per second for comparison with Warren's results in 1867, it was assumed that the water surfaces at the two stages of the

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river were parallel, and that the same corrections, + 1.282 feet at Portage, would correctly apply to all the soundings. This is not correct, but the soundings were so reduced to make the results comparable with the results already published in the former report of the Board of Engineers.

Unfortunately, readings of the gauges at the ganging stations were not obtained at both stages of the river either in 1885 or 1886, but since the results show that there has been no further reduction of the low-water plane since 1882, nor much change in the stage corresponding to a discharge of 3,360 cubic feet at Portage during the past year, we may determine very closely the limits of the errors introduced into the results on pages 2099 and 2100 of this report, by assuming that the slopes of the river were probably the same in 1885 and in 1886 at the same gauge-readings at Portage. In 1886 we have the levels of the water surfaces at Portage, Baraboo River, and Dekorra, at the stage the soundings were made, *i. e.*, at —1.21 feet on the Portage gauge, and in 1885 we have them at a stage 0.072 foot on the Portage gauge corresponding to the discharge 3,360 cubic feet per second in 1886.

The differences between the levels of these water surfaces will show the corrections to be applied to the soundings in the vicinity of these stations, at—1.21 feet on the Portage guage, to reduce them to a stage 3,360 cubic feet per second discharge at Portage:

Year.		At Portage.	Baraboo River.	Dekorra.
		Feet.	*Feet.*	*Feet.*
1886	Reference of water surface at reading—1.21 feet at Portage ..	21.618	14.015	9.95
1885	Same at reading 0.072 foot, Portage gauge corresponding to 3,360 cubic feet discharge	22.890	14.824	11.05
	Reduction	+1.282	+0.819	+1.10

Mean reduction = +1'.07.

The reduction actually applied to the soundings was + 1.282 feet, hence the resulting depths of pools and bars in table on page 2100 of this report may be in error to an extent equal to—0.21 foot, the depths therein given being probably too great by that amount. The error, then, if any, is *favorable* to the improvement.

LOW-WATER DISCHARGES AT THE MOUTH OF BARABOO RIVER AND AT DEKORRA.

The discharge observations at Baraboo River and at Dekorra, taken during the past season and submitted herewith, were reduced in the same manner as those at Portage, and there results therefrom the facts that the discharges at the stage corresponding to a discharge of 2,114 cubic feet per second at Portage are, at the mouth of Baraboo River, 2,447 cubic feet per second, and at Dekorra 2,489 cubic feet per second, or the low-water discharge of the Baraboo River is 333 cubic feet, and of Rocky Run and Duck Creek is 42 cubic feet per second.

The low-water surface at Dekorra corresponds to a reading 0.0 foot on the Dekorra gauge. The Baraboo gauge is a temporary one, but the low-water surface at the gauge in 1886 was 4.015 feet above the zero of the Dekorra gauge, and 4.315 feet below the upper miter-sill of Portage Lock. The location of the gauge is shown on the map, which references are

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sufficient in the future to re-establish this gauge, or to compare water-levels in the future.

EFFECTS OF LOWERING THE WATER PLANE.

On page 2100 of this report it is stated that in 1885 the low-water plane was 0.888, and in 1886 0.837 foot lower than in 1867. Applying these reductions to the gauge records at Portage for 1885 and 1886, and continuing the tables given in the last report of the Board of Engineers on pages 1906, 1907, Report of the Chief of Engineers for 1884, we get the results shown below:

Year.	Gauge record considered.	Extreme low water.	Depth 0 to extreme low water.	Depth 0 to 1 foot.	Depth 1 foot to 2 feet.	Depth 2 to 3 feet.	Depth 3 to 4 feet.	Depth 4 to 5 feet.	Depth 5 to 6 feet.	Depth 6 to 7 feet.	Depth 7 to 7.3 feet, inclusive.	Total days.
		Feet.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	
1871	Aug. 28 to Oct. 5, incl ..	0–0. 1	.....	39	.....	.....	.....	.....	.....	.....	.....	39
1872	Apr. 10 to Nov. 9, incl ..	0–0. 2	42	81	30	39	17	5	.....	.....	.....	214
1873	Apr. 1 to Nov. 18, incl..	0–0. 4	9	105	34	33	31	16	4	.....	.....	232
1874	Apr. 17 to Nov. 20, incl.	0–0. 4	44	52	72	25	23	2	.....	.....	.....	218
1875	May 9 to Nov. 20, incl..	0–0. 2	5	76	45	35	23	10	.....	.....	.....	196
1876	Apr. 1 to Dec. 2, incl...	0–0. 1	2	43	81	21	30	11	32	23	.....	246
1877	Apr. 1 to Nov. 30, incl..	0–0. 6	71	50	77	41	5	.....	.....	.....	.....	244
1878	Apr. 1 to Nov. 30, incl..	0–0. 5	23	52	124	30	13	2	.....	.....	.....	244
1879	Mar. 27 to Dec. 15, incl.	0–0. 5	56	80	80	36	5	4	3	.....	.....	264
1880	Mar. 6 to Nov. 15, incl..	0. 0	.....	97	49	27	35	24	11	8	4	255
1881	Apr. 15 to Nov. 30, incl.	0–0. 2	5	38	23	37	51	35	17	20	4	230
1882	Mar. 1 to Nov. 30, incl..	0–0. 3	9	36	49	95	46	25	9	6	.....	275
1883	Mar. 1 to Nov. 30, incl..	0. 0	.....	32	81	77	54	16	5	10	.....	275
1884	Mar. 1 to Nov. 30, incl..	0–0. 1	2	32	62	56	58	28	17	23	1	275
1885	Mar. 1 to Nov. 30, incl..	0–0. 05	.....	61	50	82	40	23	15	4	.....	275
1886	Mar. 1 to Oct. 31, incl...	0–0. 93	41	42	61	39	30	13	7	6	6	245

Table of extreme low waters, corrected for the lowering of the water plane.

Year.	Extreme low water in reference to the zero of Warren's gauge, 3 feet above miter-sill.	Extreme low water in reference to the calculated zero of the particular year.
	Feet.	
1871	0. 1	For these years the record must remain unaltered, as no data exist for correction.
1872	−0. 2	
1873	−0. 4	
1874	−0. 4	
1875	−0. 2	
1876	−0. 1	0′. 0
1877	−0. 6	−0′. 4
1878	−0. 5	−0′. 2
1879	−0. 5	−0′. 055
1880	0. 0	0′. 61
1881	−0. 2	0′. 67
1882	−0. 3	0′. 7
1883	−0. 0	1′. 0
1884	−0. 1	1′. 0
1885	0. 05	−0′. 93
1886	−0. 91	−0′. 145

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Table showing the duration of the stages of water at Portage in reference to the zero of the particular year.

	1867.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days*	*Days.*	*Days.*	*Days*	*Days.*
Between extreme low water and zero of the year	0	64	7	2	0	0	0	0	0	0	10
Between zero of the year and five-tenths of a foot above	4	22	23	61	0	0	0	0	0	0	21
Between zero of the year and 1 foot above	29	48	51	102	46	9	7	3	3	1	15
Between 1 foot and 2 feet	96	103	130	75	80	40	39	31	34	62	45
Between 2 feet and 3 feet	21	48	69	64	32	21	62	81	61	50	56
Between 3 feet and 4 feet	33	12	14	12	42	32	84	75	50	81	41
Between 4 feet and 5 feet	9	.....	4	3	30	38	42	54	53	40	27
Between 5 feet and 6 feet	30	.....	.....	6	13	27	28	16	26	23	12
Between 6 feet and 7 feet	28	.....	.....	.....	4	15	8	6	20	18	4
Between 7 feet and 8 feet	....	.....	.....	.....	10	20	5	9	22	0	9
Number of days observed	246	275	275	264	257	202	275	275	275	275	245
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Lowest water in reference to zero of the year	0.0	—0.4	—0.2	—0.055	0.61	0.6	0.7	0.4	0.8	1.0	—0.145
Highest water in reference to zero of the year	6.65	3.45	4.35	5.945	7.91	8.07	7.2	7.5	8.0	7.3	8.8

NOTE.—Five days in 1886 when water was between 8 and 9 feet above zero of year.

By the phrase "zero of the particular year," used for this table, is meant the level of the water in that year, corresponding to the same discharge as when the water stood at zero at Warren's gauge in the years preceding the construction of the works of improvement.

From the table on page 11 of this report it will be seen that the improved section of the river in 1886 has a mean depth on bars at 0.3 foot below ordinary low water of 2.97 feet. In September, 1882, this mean depth was 3.27 feet, and in 1867, 2.46 feet. The above result was arrived at in 1886 by correcting for filling below 0.7 foot on Warren's gauge, corrected for lowering of the water plane, which correction amounted to — 0.14 foot. Omitting this correction the mean depth on bars in 1886 is 3.11 feet at a stage 0.3 foot below ordinary low water, which shows an improvement over the unimproved river in 1867 of about 0.65 foot, and a slight deterioration in depth since 1882.

The least depths on bars, at a stage 0.3 foot below ordinary low water, were in 1867 1.10 feet, 1.20 feet, 1.80 feet, 2.10 feet, 2.10 feet, 2.10 feet, 2.20 feet, 2.20 feet, 2.20 feet, 2.3 feet, and in 1886, 2.15 feet, 2.65 feet, 1.95 feet, 3.25 feet, 2.95 feet, 3.15 feet, 2.35 feet, 2.85 feet, 2.20 feet, 2.20 feet, 2.60 feet, 2.30 feet, 2.0 feet, 2.0 feet.

Showing an improvement in 1886 over 1867 of about 0.85 foot in least depths.

It is also shown that in the present condition of the river it will require a rise of 2.05 feet above the ordinary low-water stage to give a navigable stage of 4 feet of water throughout the improved section over the bars of least depths. The table showing the duration of the stages of water at Portage given on page 14 of this report shows that there were 46 days in 1882, 34 in 1883, 37 in 1884, 63 in 1885, and 91 days in 1886,

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when there was a depth available for navigation less than 4 feet from Portage to Dekorra.

Upon consulting the map of the low-water survey of the Wisconsin, submitted with this report, it will be seen that the best channel is a mere thread of water, meandering in and out among the sand-bars and dams, with short and abrupt bends and crossings, which crookedness of channel, taken in connection with the shifting nature of the channel-way, and the current of the stream, make navigation for vessels of the length adapted to the locks on the Fox River nearly impossible, even if sufficient depth of channel existed.

As bearing upon the character of the river, and the navigability of the channel from Portage to Dekorra, some 22 slope gauges were established and read at low water for slope at low water of the water-surface. These slopes for a stage corresponding to a reading — 1.21 feet on the Portage gauge, or — 0.055 foot below the ordinary low-water stage, at which the soundings were taken, are given in the following table:

Slope at low water (— 1.21 feet on Portage gauge).

No. of gauge.	Location.	Water-surface.	Difference of level.	Distance between gauges.	Slope per mile.
		Feet.	*Feet.*		*Feet.*
1	Portage Lock	21.608			
2		21.533	0.075	350	1.131
3		21.448	0.085	1,057	0.425
4	Fire Dock	21.001	0.447	1,570	1.503
5		19.755	1.246	3,211	2.048
6	Wood's Island	19.243	0.512	2,458	1.100
7	Head of Wood's Slough	18.758	0.485	2,330	1.099
8	26	18.231	0.527	1,527	1.822
9	28	11.771	0.460	1,490	1.630
10	30	16.940	0.831	1,556	2.820
11	Harlet Island	16.783	0.157	1,480	0.560
12	Rattlesnake Island	16.358	0.425	2,180	1.029
13		15.635	0.723	1,658	2.302
14	40	14.650	0.985	2,665	1.952
15	Above Baraboo River	14.064	0.586	1,910	1.620
16	Below Baraboo River	13.995	0.069	1,156	0.317
17	Head Pine Island	13.749	0.246	1,640	0.792
18	50	13.368	0.381	1,478	1.362
19	Pine Island	12.604	0.764	2,104	1.915
20	53	11.616	0.988	2,380	2.192
21	Above Rocky Run	10.166	1.450	2,777	2.760
22	Below Rocky Run	9.679	0.487	1,210	2.124

Slope per mile from Portage to gauge 15, Baraboo River, 4.818 miles, = 1,565 feet.

Slope per mile from gauge 15, Baraboo River, to gauge 22, Dekorra, 2.413 miles, = 1.811 feet.

From which it is apparent that the improved section is still a succession of pools and bars, ponds and rapids, and that improvement of the river by eliminating the bars will result in diminishing the depths of the pools and equalizing the slopes and lowering the low-water plane, without materially increasing the depth of water in the channel, unless further contraction is resorted to.

It is my judgment that the degree of contraction already practiced on the Wisconsin River, viz, to 300 feet between the heads of the wing-dams, is as great as can be safely and economically done. Further contraction will produce dangerous scour, a lowering of the water plane, and injury to the angles and training-walls of the dams, from undermining. The dams would be, then, much more expensive and difficult to maintain on such insecure foundations. Besides this objection to

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further contraction, a narrow channel in a river with such a slope and current and small depth is in itself a cause of serious obstruction to ascending boats, even when the depth is sufficient for the draught of the boat, due to the piling up of the water at the bow of the boat from the resistance by friction and insufficient water-way to its passage to fill the space behind, vacated by the boat in its progress. For even approximately free or easy navigation on shallow streams of such slope wide channels are necessary.

During the seasons of 1884 and 1885 it was found necessary to make repairs to the dams on the Wisconsin River to confine to the channel-way the discharge of the Wisconsin. These repairs were restricted to what were absolutely necessary to answer a special purpose, and with no view to anything more than temporary objects. The dams are in fair condition, but have settled somewhat, and the crests are becoming lowered also from rot and breaking of the brush of which they are composed.

The annually recurring exposure of the crests of the dams to the air and moisture for months each year can but result in the necessity for replacing these crests with fresh material from time to time. The dams also are frequently cut away from the bank at their shore extremity at high water; but this kind of damage has not been as frequent as might be expected, less than 10 per cent. of the dams having been injured in six years from this cause.

The expenditures for repairs on the 6 miles of dam were, in	1884	$3,364.07
	1885	3,663.34
Total for two years		7,027.41

or $585 per mile of channel per annum.

The same rate applied to the entire length of the river from Portage to Prairie du Chien would indicate an annual expense for maintenance of $69,030. In addition, the crests of all the dams would probably have to be rebuilt once in about nine years, at an expense of about one-fifth of the original cost of the dams.

The present needs of commerce and navigation for this work are fully discussed by Col. D. C. Houston on pages 1925 to 1927, Report of the Chief of Engineers for 1884; and in his conclusions that the demands of commerce do not at present require the improvement of the Wisconsin River and the completion of the project, I concur.

As originally projected, even granting the practicability of improving at reasonable expense the open-river navigation of the Wisconsin River sufficiently to give 4 feet in depth of water from Portage City to the Mississippi River, which is extremely doubtful, it is my opinion that the Wisconsin River can never form part of a *cheap* or effective route of transportation compared with railroads, for the following reasons:

(1) The channels will necessarily, as shown herein, be so narrow and tortuous at low water, and so obstructed by submerged dams with water flowing over their crests at varying angles to the channel at medium stages, that free or easy navigation can not be attained.

(2) That the depth of 4 feet is insufficient, especially when rapid currents are to be overcome by steam machinery, to enable sufficient loads to be carried on the decks or in the holds of steam-boats of the size admitted by the locks on the Fox River, in addition to the machinery and fuel of the boat itself, at any rates of freight that can compete with present railroad rates and at a profit.

(3) Owing to the narrow, tortuous, and shifting channels, the rapid currents, and the submerged dams, the improved stream can not be navigated with safety at night, nor can towing be done to advantage or at

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all at low water, especially up-stream or from the Mississippi River eastward, the direction of the heavier freights.

The competition of railroads has become so severe, their tracks and rolling-stock are so much improved, that no 4-foot water-course can compete with them on advantageous terms except under the most favorable conditions as to moderate currents and commodious channels that offer facilities for towing. Even in wide channels of moderate depths, towing up-stream is not advantageously done against railroad competition when the currents exceed 4 feet per second, as they do on the Wisconsin River whenever the stream is sufficiently high to allow barges in tow drawing 4 feet of water or more to pass over the dams.

Owing, then, to the problematic character of this work, its great probable cost, the probable cost of maintaining a great development of brush-dams with their crests continually rotting away above the low-water marks, and the insufficient and difficult shifting channel-way when completed, it is my opinion that no further work should be done upon the Wisconsin River directed to securing an open-river channel in connection with the slackwater navigation on the Fox River for a through route of transportation.

If such a route is necessary, the project should embrace a certainly practicable solution of the problem, which can only be found in a canal from Portage to the Mississippi.

With reference to the work on the Fox River I have to refer to the report of a Board of Engineers convened in 1884 to consider its navigation, and to a modification of the project of that Board made by authority of the Chief of Engineers, as shown by my letter and indorsements thereon (copies of report, and letter and indorsements, herewith), dated April 30, 1886.

The work on the Fox River, therefore, at present is directed to the deepening and widening the channels of the Fox River and canals below Montello to 6 feet deep and 100 feet wide; to the rebuilding the Cedars Lock with stone, and to keeping in repair the old locks and other works on the Fox River. For completion of this work an estimate is made of $602,000.

Financial statement to date.

Fox River, total expenditures	$1,876,794.31
Wisconsin River, total expenditures	590,075.84
Total	2,466,870.15

OPERATING AND CARE, ETC.

The estimates for the original work are all contained in the report of the Board of Engineers in 1884, and are not again repeated herein.

There are submitted herewith—

1. A map of the Wisconsin River from Portage to Dekorra, survey at low water, 1886, in two sheets.
2. Gaugings of the Wisconsin River at Portage; below mouth of Baraboo River, and at Dekorra, computation sheets.
3. Gauge-reading at Portage, Baraboo, and Dekorra, and intermediate gauges, July and August, 1886.
4. Summary of the discharge observations.
5. Readings of slope gauges No. 1 to No. 22, 1886.
6. Copy of letter and indorsements modifying project of Board of Engineers, submitted September 17, 1884.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX I I.

IMPROVEMENT OF THE HARBORS OF CHICAGO AND CALUMET, ILLINOIS—IMPROVEMENT OF THE ILLINOIS AND CALUMET RIVERS—SURVEYS FOR HENNEPIN CANAL.

REPORT OF MAJOR THOS. H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chicago Harbor, Illinois.
2. Calumet Harbor, Illinois.
3. Illinois River, Illinois.
4. Calumet River, Illinois and Indiana.

EXAMINATIONS AND SURVEY.

5. For Hennepin Canal.
6. Farm Creek, Illinois, with a view to changing its course.
7. Calumet River, Illinois, from the forks of the river near its entrance into Lake Calumet to Riverdale; and also from Riverdale to Blue Island.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 25, 1887.

SIR: I have the honor to transmit herewith annual reports upon the works in my charge during the fiscal year ending June 30, 1887.

These works were in charge of Maj. W. H. H. Benyaurd, Corps of Engineers, from the beginning of the year to November 19, 1886.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

II 1.

IMPROVEMENT OF HARBOR AT CHICAGO, ILLINOIS.

The project of improvement now in course of execution at this harbor was adopted in 1870 and modified in 1878. The objects sought are: first, the formation of an outer harbor adjoining the entrance to the Chicago River, with the view to increasing the facilities for accommodating the lake commerce of the city of Chicago and also relieving the river, commonly known as the inner harbor, from its overcrowded condition; second, the formation of a harbor of refuge by the construc-

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tion of an exterior breakwater outside the outer harbor, in deep water where good anchorage is found, from whence safe access to the outer harbor and the river can always be had, and to which vessels in the southern end of Lake Michigan can always run when under stress of weather.

OUTER HARBOR.

That part of the present project which relates to the outer harbor consists in inclosing a basin south and east of the present mouth of Chicago River, which contains an area of about 455 acres. A dock-line was established by the Board of Engineers, convened by virtue of Special Order 108, Corps of Engineers, August 3, 1871, essentially parallel to and about 2,000 feet west of the breakwater which limits this basin on the east. This line is about 1,300 feet east of the west shore of the basin which is now the bulkhead protecting the Illinois Central Railway track. The area included between the dock line and the east breakwater is about 270 acres. The depth of water over this was originally between 10 and 19 feet. The project contemplates that it shall be dredged to a depth of 16 feet. The amount of material yet to be removed from this area is about 267,000 cubic yards. The remaining 185 acres of the inclosed basin has been reserved for piers and slips, to be built upon plans to be approved by the Secretary of War after it has been legally determined to whom the submerged lands in this area rightfully belong. This matter has long been in controversy and is now fairly before the circuit court of the United States for the northern division of the State of Illinois, with the United States a party in interest.

The works built by the United States for inclosing this basin have been completed for some years. They are known as the North Pier, the Easterly Breakwater, and the Southerly Breakwater. These structures seem to answer very well the purpose for which they were built.

During a svere storm which occurred on December 4, 1885, a portion of the southerly breakwater was considerably damaged. An estimate for repairing this damage was submitted by my predecessor in charge of this work, in his annual report for last year. During last fall about 645 cords of stone were placed in this breakwater to replace those that had been washed out from time to time since its construction. With this exception no work was done on the outer harbor during the present fiscal year.

Early in May, at the commencement of the working season of this year, a careful examination was made at the break in the southerly breakwater. It was then ascertained that no additional damage had resulted to the structure since this opening was made. The débris of the cribs turned over still lie in the opening and serve to break up the storm waves before they enter the basin. It does not appear that additional damage of this character to this work need at present be apprehended. In view of this fact it was thought best to defer the contemplated repairs to the southerly breakwater until such time as additional appropriations might become available, and to expend the present available funds on the more important work of extending the Exterior Breakwater, and thus enlarging as far as practicable the area in which storm-driven vessels in this vicinity could find shelter.

The characteristic structure for the works of improvement at our lake harbors is a crib of timber resting upon the bottom of the lake, filled with stone, and rising above the surface of the water to a height from 6 to 8 feet. The width and the method of putting the crib together and securing its foundation varies with circumstances and the individual

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notions of the officer in charge. The general features, however, remain the same. The portion of this structure that remains constantly wet will last for an indefinite length of time, provided there is no other element of destruction to contend with than ordinary decay. The part that is above the surface of the water and subject to alterations of wet and dry, will, after a few years, become enfeebled by decay of the timber used and be washed away by the storms.

Experience seems to indicate that about twelve years is the practical limit of durability for the superstructure of these works. A due regard for the safety of the other portions of these works, likewise for the interests protected by them, would seem to demand that these superstructures be renewed at least once in this period, if we continue to use in their construction so perishable a material as wood. Each renewal is attended with considerable expense. I estimate that for this item alone the Government piers and breakwaters in Chicago Harbor will, from this time on, require a yearly appropriation of $25,000 if some material of a more durable nature than that now used is not adopted.

The superstructure on the works of the outer harbor has been exposed for periods varying from eighteen to seven years. Much of this is very much decayed, and is liable at any time during one of the storms that visit this locality to be washed from its foundations. The decay seems to have taken place on the inner or harbor side of the work to a much greater extent than upon the outside. This probably arises from the fact that the outside timbers above the ordinary line of the water are less frequently dry than are those upon the inside, and are therefore not so liable to decay.

The superstructure should be renewed as soon as practicable upon the whole of the easterly breakwater and a portion of the north pier, being together about 4,738 feet.

The question of renewing the present wooden superstructures with some material of a more durable character has been under consideration for some time. The project submitted to the Chief of Engineers under date of February 9, 1887, seems to me well adapted to this locality, and commends itself to a favorable consideration, both on account of its economy and the facility with which it can be constructed. Artificial stone and concrete in various forms are now being extensively used for outside facing, as well as for the mass of the work, in the construction of quays, piers, breakwaters, and other similar structures in almost all parts of the world. This is notably so in England, the north of Scotland, Canada, and other countries, where the severity of the climate and storms subject it to a test of the most practical and convincing character, exceeding any that it would be subjected to in this latitude.

To renew the superstructure of the outer harbor with durable material, as suggested in that project, would cost about $23 per linear foot. To renew with wood, as in the present structure, the cost would be about $17 per foot. When we consider that the first will last for an indefinite number of years with very small expense for repairs, and the second only for a short time, there can be no doubt as to which of the two should be adopted.

EXTERIOR BREAKWATER.

This structure is located about a mile to the northeast of the mouth of the Chicago River. When finished it will be 5,436 feet in length. At the end of the fiscal year there was 1,200 feet of substructure and 1,600 feet of superstructure to be constructed in order to complete the breakwater.

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The work done during the year consisted in placing two courses of superstructure over 600 feet of crib-work and six courses over 100 feet; replacing several cords of stone that had been washed out of the superstructure at various places during storms. The crib on the east end of the breakwater had been much damaged by vessels and storms. This was repaired. The four cribs that were built during the year ending June 30, 1885, to about their sixteenth course, and had been lying in the outer harbor since that time, were finished and placed in position and filled with stone. Since the commencement of the present working season, May 1, a riprap of stone to a height of about 8 feet has been placed along both sides of these four cribs, in order to obtain greater stability and render them less liable to be disturbed by the action of heavy seas.

The amount of stone that was paid for during the year and used in the construction and repairs to the exterior breakwater was 3,712.52 cords.

After putting the superstructure upon the 400 feet of breakwater left unfinished at the end of the fiscal year, the quantity of lumber on hand will be sufficient for the completion of about 400 feet more.

The utility of this breakwater, which forms the real harbor of refuge at this port, is now fully acknowledged. Many vessels take refuge behind it during storms, and many others are enabled through its instrumentality to enter the outer harbor and the river at times when they could not otherwise do so. Its usefulness would be very much increased were it completed, and it is hoped that Congress will, at an early day, appropriate the money for this purpose. Were this now available the breakwater could be finished in a few months, and the whole of the present project for improvements at this place, including the unfinished dredging of the outer harbor, completed before the winter weather set in. It is unfortunate that this is not so.

PROPOSED APPLICATION OF FUND AVAILABLE.

The amount available July 1, 1887, is $20,974.11. So much of this as may be necessary will be at once expended in putting the superstructure upon the uncompleted 400 feet of the exterior breakwater; the remainder will be used in the further extension of the breakwater and in the care and preservation of the public property pertaining to the works.

ESTIMATE FOR THE YEAR ENDING JUNE 30, 1889.

For the purpose of continuing the work of improving Chicago Harbor under the existing project the sum of $24,000 is asked. For the purpose of renewing the superstructure upon the easterly breakwater and a portion of the north pier the sum of $120,000 is asked.

Chicago is the port of entry in the collection district of Chicago. There is a lighthouse on the shore end and a beacon-light on the lake end of north pier. There is also a beacon-light on the south end of the easterly breakwater.

Money statement.

July 1, 1886, amount available		$574.95
Amount appropriated by act approved August 5, 1886		75,000.00
		75,574.95
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$53,644.37	
July 1, 1887, outstanding liabilities	956.47	
		54,600.84
July 1, 1887, amount available		20,974.11

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AGO HARBOR

ILLINOIS

June 30th 1887

SCALE:

00 2000 3000 4000 5000 FT.

U. S. Engineer Office

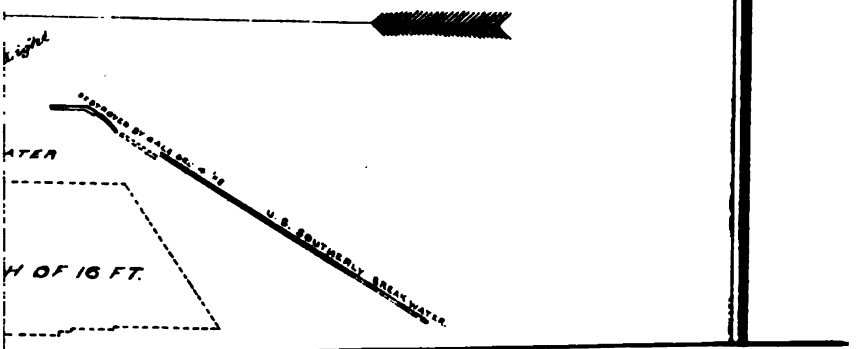
Chicago, Ills. July 25. 1887.

pt to Chief of Engineers U.S. Army with

nual Report for the fiscal year ending

ne 30. 1887. *Thos H. Handbury.*

Major, Corps of Engineers, U.S. Army.



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Amount (estimated) required for completion of existing project.....$240,000.00
Amount (estimated) required for renewing superstructures of the easterly breakwater and a portion of north pier..... 120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 360,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The following statistics for the fiscal year ending June 30, 1887, were furnished by the collector of customs for this port:

	Number.	Tonnage.
Vessels entered	12,226	4,202,838
Vessels cleared	12,280	4,311,667
Total	24,506	8,514,505

Duties on imports, fees, etc., collected, $4,620,770.26.

Referring to Department letter of August 10, 1886, and the subsequent one of April 4, 1887, I am required to state in regard to these works of improvement:

(1) The amount expended, the amount required to complete improvement, and the annual cost of preserving and maintaining.

(2) The amount of commerce and navigation when the work of improvement began.

(3) The amount of commerce and navigation present time.

(4) The effect, if any, of work thus far executed in each case upon the rates of freight and insurance, and also upon the rates of competing routes of transportation.

(5) Prospective advantage to commerce, as well as benefits to the community, by the completion of this proposed improvement.

Replying to these points seriatim:

(1) Total amount expended from the commencement of work in 1833 to June 30, 1887..... $1,777,180.07
Balance available June 30, 1887..... 20,974.11
Estimated balance yet unprovided that will be required to complete work at present projected..... 240,000.00

The portion of these works that is constantly beneath the surface of the water, it is assumed, will last for an indefinite time. The cost of preserving and maintaining this will therefore be small. The superstructure, however, so long as it is made of wooden cribs filled with stone, as is now the case, will be a constant source of expense to keep in repair.

Experience seems to indicate that twelve years is about the average life of these superstructures. If the policy of making them of so perishable a material as wood is adhered to, we may expect to be obliged to renew them at least once in this time. On this basis the completed and projected Government works at this harbor will require for their maintenance and repair an average of at least $25,000 a year.

The question of substituting for the perishable material of the present superstructure something of a more durable nature is now being investigated.

(2) From what seems to be a reliable history of early Chicago I obtain the following information bearing upon the early commerce of this harbor:

In 1833, three brothers, Leonard C., Peter D., and Hiram Hugunin, sailed a yacht, named *Westward Ho*, from Oswego to Chicago. In the month of August, after a voyage of nearly three months, they arrived outside the sand-bar, went ashore, hired eight yoke of oxen, and hauled their vessel over the barricade into the river. The *Westward Ho* may therefore be considered the first lake boat belonging to private parties to fairly enter the river.

In 1836 the value of the exports was $1,000.64, and the value of imports $325,203.90.

Such was the beginning fifty years ago of the lake commerce of Chicago, the coastwise vessels of which arriving and departing now number once and one-half the aggregate of like vessels arriving and departing at the seven largest sea-coast cities of the United States. This, too, notwithstanding that the harbor is ice-bound for four months in the year.

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(3) The following statistics, selected from data furnished by the collector of customs at this port, will give a general idea of the business done during the year ending December 31, 1886:

Trade by lake in shipment of grain to foreign ports:

	Bushels.
Wheat	1,108,174
Corn	7,666,359
Oats	1,347,012
Total	10,121,545

Exports to Canada.

Articles.	Quantity.	Value.
	Bushels.	
Wheat	1,092,909	$859,957.90
Corn	2,396,221	946,363.29

COASTWISE SHIPMENTS.

Flour	barrels..	1,310,077
Merchandise	packages..	1,157,299
Wheat	bushels..	10,559,766
Corn	do....	38,572,270
Oats	do....	3,216,510
Flax-seed	do....	3,549,466

COASTWISE RECEIPTS.

Merchandise	packages..	4,749,782
Lumber	M..	1,427,760
Iron ore	tons..	418,106

Arrival and clearances of vessels.

Vessels.	Number.	Tonnage.
Arrived	10,180	3,546,309
Cleared	10,254	3,590,276
Total	20,434	7,136,585

Value of and duties collected on imported merchandise during the year, $11,574,449; duties, $4,349,237.46.

Duties collected for the past five years.

1882	$3,696,711.09
1883	4,025,116.85
1884	4,071,188.78
1885	3,959,014.12
1886	4,349,237.46
Total	20,101,268.30

Internal revenue collected in the first district of Illinois during the year, $7,982,005.66.

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Statement of vessels entered and cleared (foreign and coastwise) and the aggregate receipts at certain ports of the United States for the year ending June 30, 1886.

[From the annual report of the Supervising Special Agent to the Secretary of the Treasury, page 9.]

Port of—	Arrived.			Cleared.			Grand Total.	Aggregate receipts.
	Foreign.	Coastwise.	Total.	Foreign.	Coastwise.	Total.		
Baltimore	566	1,515	2,081	625	1,664	2,289	4,370	$2,601,440
Boston	2,622	789	3,411	2,559	878	3,437	6,848	21,079,311
New Orleans	744	264	1,008	707	271	978	1,986	1,361,877
New York	5,783	1,989	7,772	5,219	3,196	8,414	16,187	134,472,003
Philadelphia	1,341	743	2,084	1,013	1,318	2,331	4,415	14,661,896
Portland and Falmouth	307	358	665	417	357	774	1,439	840,598
San Francisco	759	198	957	771	441	1,212	2,169	5,900,632
Total	12,122	5,856	17,978	11,311	8,125	19,436	37,414	180,007,757
Chicago	155	10,794	10,949	377	10,770	11,147	22,096	4,099,550

Comparative statement of vessels entered and cleared (foreign and coastwise) at certain ports of the United States for year ending June 30, 1886.

I.

Ports of—	Arrivals.	Clearances.	Total.
Baltimore	2,081	2,289	4,370
Boston	3,411	3,437	6,848
New Orleans	1,008	978	1,986
Philadelphia	2,084	2,331	4,415
Portland and Falmouth	665	774	1,439
San Francisco	957	1,212	2,169
Total	10,206	11,021	21,227
Chicago			22,096

II.

New York	7,772	8,415	16,187
New Orleans	1,008	978	1,986
Portland and Falmouth	665	774	1,439
San Francisco	957	1,212	2,169
Total	10,402	11,379	21,781
Chicago			22,096

III.

New York	7,772	8,415	16,187
Baltimore	2,081	2,289	4,370
Portland and Falmouth	665	774	1,439
Total	10,518	11,478	21,996
Chicago			22,096

IV.

New York	7,772	8,415	16,187
Philadelphia	2,084	2,331	4,415
Portland and Falmouth	665	774	1,439
Total	10,521	11,520	22,041
Chicago			22,096

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Comparative statement of vessels entered and cleared, etc.—Continued.

COASTWISE ONLY.

Ports of—	Arrivals.	Clearances.	Total.
Baltimore	1,515	1,664	3,179
Boston	789	878	1,667
New Orleans	264	271	535
New York	1,989	3,196	5,185
Philadelphia	743	1,318	2,061
Portland and Falmouth	358	357	715
San Francisco	198	441	639
Total	5,856	8,125	13,981
Chicago	10,794	10,770	21,564

A general idea only of the importance and extent of the lake commerce of Chicago is conveyed by the above selections. No attempt is made to include the numerous articles handled in smaller quantities whose aggregate would make a respectable showing in itself.

From a casual inspection of the above tables it is at once apparent that the works of improvement now in process of construction by the United States Government at Chicago Harbor, when considered in relation to the amount of commerce and the number of vessels to be benefited by them, are of the utmost importance, not only from a local but a national point of view. They should receive consideration, and be appropriated for in proportion to this importance.

(4.) The effect of the work thus far executed upon the rate of insurance it would be difficult to ascertain. There are so many factors influencing the cost of this item that it would be impracticable to determine just how much could be attributed to the Government works. Of two ports alike in all respects, excepting that one has facilities for exit and entrance under all circumstance of wind and weather while the other has not, the average rate of freight and insurance to the former must, of course, be less than to the latter.

With regard to the influence of the works of improvement upon the rates upon competing routes of transportation, this is another question to which, in this case, it is difficult to give explicit answer.

Nature gave to this harbor only position. Its importance to the commercial world is derived from this fact. Naturally it had no more harbor facilities than many other points along the sandy shores of Lake Michigan. It was its position in relation to the general geography of the country and to the natural land and water routes for transportation that made, first, access to the river or inner harbor, second, the construction of an outer harbor, and third, the construction of a harbor of refuge—all by artificial means—an absolute necessity. These have contributed in no small degree to give to Chicago that position of commercial eminence that she now enjoys. If these works were not in existence the lake commerce, which is such an important factor in the prosperity of the city, would be little or nothing. The competing routes of transportation which are by rail would be in a condition similar to that which exists where there are no means of water transportation. The railroad interest would then fix the rates as high as the traffic would bear. The influence that water transportation has upon freight rates over railroad routes is well exemplified by the alacrity with which these rates are raised as soon as the season for navigation is closed. The published tariff rates, for instance, show that in the matter of flour and grain from Chicago to the seacoast, the charges are at least 25 per cent. more when lake navigation is closed than when it is opened. It is reasonable to suppose that, under a condition of affairs where full advantage could not be taken of the facilities offered by the lake route of transportation—such, for example, as a want of proper harbor accommodations—the competing routes will take advantage of this fact, and increase their rates accordingly.

(5.) The prospective advantage to commerce and benefits to the community are set forth above. It is the lake that has made it possible for the railroads to make Chicago what it is to-day. The works of improvement have been and will continue to be necessary to make the lake available.

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II 2.

IMPROVEMENT OF HARBOR AT CALUMET, ILLINOIS.

The object of this improvement is to provide a safe and reliable entrance to Calumet River and the port of South Chicago. It is proposed to accomplish this by the construction of two parallel piers 300 feet apart, projecting from the shore to deep water in the lake, and by dredging the channel-way between them to a depth sufficient to accommodate the largest class of vessels seeking the port.

This work was commenced in 1870, and at the close of the fiscal year ending June 30, 1887, 3,640 linear feet of the north pier and 1,870 feet of the south pier had been completed, making a total length of pier-work of 5,510 feet.

The total amount of material dredged from the harbor, from the beginning of operations in 1870 to the present time, is 384,376 cubic yards.

The work done during the year consisted in extending the south pier 150 feet further into the lake, in accordance with the present approved project. This work was done by contract awarded to Hiero B. Herr & Co.

The condition of the work June 30, 1887, remains about the same as when reported upon by my predecessor in his annual report for last year, with the additional deterioration due to the exposure of another year.

Additional stone filling is needed in the superstructure of both piers to the extent of about 1,000 cubic yards. This at the last contract price for stone—$9 per cord—will require $9,000 to be appropriated for this purpose.

There is yet 150 feet of the south pier to be built in order to complete the existing project for pier-work. When this is completed there will be required a certain amount of dredging from time to time in order to preserve the harbor. The estimate for this will be renewed as soon as the effect of the completed pier-work can be ascertained.

The harbor of Calumet is at South Chicago, in the collection district of Chicago. There is a light-house and a keeper's dwelling on the Government reservation, near the shore end of the north pier. A beacon light is maintained at the extremity of that pier to mark the entrance to the harbor.

Money statement.

July 1, 1886, amount available	$380.47
Amount appropriated by act approved August 5, 1886	10,000.00
	10,380.47
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	9,508.89
July 1, 1887, amount available	871.58
Amount (estimated) required for completion of existing project	11,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	20,400.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals received and opened November 24, 1886, for furnishing the material and labor necessary for extending the south pier at Calumet Harbor 150 feet, being two cribs, 75 feet each in length.

No.	Names of bidders.	Hemlock timber (60.351 feet, B. M.), per M, B. M.	Pine timber (22.920 feet, B. M., per M, B. M.	Pine piles 40 feet each.	W. I. drift-bolts (7,603.64 pounds), per pound.	W. I. screws, bolts, nuts, and washers (400 pounds), per pound.	Wrought spikes (50 pounds), per pound.	Stone (182.903 cords), per cord.	Cost for 75 linear feet.	Cost for 150 linear feet.
					Cents.	Cents.	Cents.			
1	Hiero B. Herr & Co....	$24	$26	$12	4	5	5	$9.00	$4,511.13	$9,022.26
2	Calumet and Chicago Canal and Dock Company	28	30	14	5	5	5	8.75	4,956.80	9,913.60

Contract awarded to Hiero B. Herr & Co., dated December 9, 1886; to be completed June 30, 1887; completed June 17, 1887.

COMMERCIAL STATISTICS.

Vessels entered and cleared during the fiscal year.

	Number.	Tonnage.
Entered	690	367,628
Cleared	668	339,511
Total	1,358	707,139

The following statistical information in regard to Calumet Harbor is submitted in compliance with Department letters of August 10, 1886, and April 4, 1887:

"(1) The amount expended, the amount required to complete improvement, and the actual cost of preserving and maintaining."

Between 1870, when the work in this harbor was first commenced by the Government, and June 30, 1887, there was expended $391,128.42. To complete the work of improving this harbor so far as it is contemplated by the present project $11,400 are yet to be appropriated. When completed the cost of preserving and maintaining this work will be about $4,500 per annum.

"(2) The amount of commerce and navigation when the work began."

At this time the outlet of the Calumet River was about three-quarters of a mile to the eastward of its present mouth. The river approached the lake from the south, and when near it was turned abruptly to the right by a long, narrow sand-bar that had been formed as the resultant of the action of the wind on the waters of the lake and the currents of the river water. The navigable depth in the river in this vicinity was at that time about 7 feet.

The improvement entered upon consisted in cutting through this bar at the turn of the river and building parallel piers 300 feet apart out to deep water in the lake. This channel-way was to be dredged to a depth of 16 feet.

Before this work was commenced but very few small crafts were able to enter Calumet River. We may say that the commerce at that time was little or nothing.

"(3) The amount of commerce and navigation at the present time."

The collector of customs at Chicago furnishes the following data in regard to the commerce at South Chicago, Calumet Harbor, during the calendar year 1886:

Vessels cleared, 546	tons..	286,359
Vessels arrived, 561	do....	305,198

RECEIPTS.

Merchandise	packages..	3,193
Lumber	feet..	39,330
Shingles	number..	9,550

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Railroad ties	do	105,985
Coal, anthracite	tons	43,489
Salt	barrels	255,132
Iron ore	tons	317,412

From the secretary of the Chicago Lumberman's Exchange I find that the following forest products were received at South Chicago during the season of 1886:

Lumber	feet	71,828,716
Shingles	number	60,309,500
Laths	pieces	10,987,000
Pickets	number	288,085
Cedar posts	do	28,835

The secretary remarks that "parties in responding to my request for particulars say: 'Our trade here is largely limited from the lack of harbor accommodations, which, if increased sufficiently, would enable us to do a great deal by water which we are now compelled to do by rail.'"

From the president of the North Chicago Rolling Mill Company I obtain the following data in regard to their business in South Chicago during 1886:

Raw material received:		
Iron ore	tons	303,000
Coal	do	120,000
Coke	do	213,000
Limestone	do	61,400
Spiegeleisen	do	13,000
Finished products:		
Bessemer pig-iron	tons	193,000
Steel ingots	do	164,000
Steel rails	do	140,000
Men employed		2,000
Cash paid out at the works in South Chicago		$1,200,000

"(4) The effect, if any, of work thus far executed in each case upon rates of freight and insurance, and also upon the rates of competing routes of transportation:"

I have thus far been unable to obtain the data necessary to a definite statement under this head. It can, however, be asserted that the effect of this improvement is the same as is observed in all cases where transportation by water is made to compete with other means. The rates of freight become perceptibly less as the facilities for water transportation are increased.

"(5) The prospective advantages to commerce, as well as benefits to the community, by the completion of the proposed improvement:"

This work of improvement, so far as it is at present projected, is now nearly completed. Its advantages to the community have been very great, as is shown by the great increase in the commerce of the harbor since the work was commenced. It has given an outlet to the Calumet River, which traverses a region possessing immense natural inducements to commerce and manufactures. Advantage is being taken of this, and every year millions of dollars are added to the capital invested here, and employment furnished to additional thousands of people. Commerce and manufacturing in this region have only just begun.

II 3.

IMPROVEMENT OF ILLINOIS RIVER, ILLINOIS.

The project now in the course of execution for the reach of the Illinois River lying between the State lock at Copperas Creek and the mouth, a distance of 135 miles, comtemplates the construction of two locks and dams and the dredging of a channel-way where necessary, so as to insure a continuous depth throughout of not less than 7 feet at low water.

The sites selected for the locks and dams are, one at Kampsville, about 30 miles above the mouth of the river; the other at La Grange, 45 miles above Kampsville. These locks are 350 feet long and 75 feet wide, with 7 feet over miter-sills at low water.

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The ultimate object of this improvement is to provide a channel-way from the lower end of Lake Michigan to the Mississippi River of sufficient capacity to accommodate large-sized Mississippi River boats, so that the products of the country may be carried from the Lake to the Gulf without breaking bulk; also to enable vessels of war of considerable capacity to pass freely from the Gulf of Mexico into the defenseless waters of our northern lakes, should the exigencies of our foreign relations ever require this to be done.

PROGRESS DURING THE YEAR.

At the La Grange lock two short return-walls were built sloping back to the rear from the land-wall. The land in the vicinity of the lock site at this point being below the level of the ordinary high water, it is necessary to fill in behind the land-wall of the lock to the extent of about 30,000 cubic yards, in order to make the space required for the service of the lock.

About 18,000 cubic yards of this filling have been put in place. A neat and substantial keeper's dwelling was built during the year. The timber for the four lock-gates was purchased and delivered. A contract was entered into May 31 with Williams, White & Co., Moline, Ill., to deliver at the lock-site the iron and steel necessary for the lock-gates, head-bay valves, maneuvering gear, etc. At Kampsville Lock the contractors commenced delivering and piling the stone contracted for under dates of November 8, 1884, and September 15, 1886, amounting in all to 2,882 cubic yards. Nothing further than paying the amounts due on these stones was done at Kampsville during the year.

In order to finish this lock there are 3,254 cubic yards of cut stone and 8,000 cubic yards of backing yet to be contracted for.

The clause of the river and harbor bill approved August 5, 1886, making appropriation for this improvement reads:

Improving Illinois River, Illinois: Continuing improvement, $112,500, of which sum $3,750 may be expended in dredging in the river in front of Peoria.

Inasmuch as there had been no project from this office submitted to Congress that contemplated any work being done by the United States for improving the Illinois River in the vicinity of Peoria, an investigation was necessary in order to ascertain, from those in whose interest and through whose influence it was supposed that the allotment of the $3,750 has been obtained, what object they had in view and in the execution of what special plan, if any, they wished the amount to be expended. This investigation was made by me, and a report submitted December 21, 1886. From the facts developed I was constrained to recommend that the discretionary power conveyed by the language of the act would be wisely exercised by withholding the authority to expend any part of the sum appropriated in dredging in the Illinois River in front of Peoria. This recommendation was concurred in by the Chief of Engineers and approved by the Secretary of War. No work, therefore, has been done in front of Peoria.

In order to complete the work projected for the improvement of the Illinois River between Copperas Creek and its mouth the following is yet to be done: At the La Grange Lock about 12,000 cubic yards of earth is to be filled in behind the land-wall; the floor of the lock-chamber to be covered with plank; the lower miter-sill stones to be set; tail-bay to be paved; the bank of the river above and below the lock to be riprapped; the lock-gates, with all maneuvering gear and valves and

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head-bay valves, to be constructed and placed, and the whole of the dam, excepting the abutments, to be built.

The timber necessary to the construction of the lock-gates and the flooring of the lock-chamber is on hand and paid for. A contract has been let for the delivery of the iron and steel work for the lock-gates, head bay valves, etc.

At the Kampsville Lock only the coffer-dam necessary to its construction and the foundation of the lock have been prepared. All the other work, including the construction of the dam, is yet to be done. Two thousand eight hundred and eighty-two cubic yards of cut stone for this lock are now at the lock-site. The balance is yet to be contracted for. The amount of material necessary to be dredged in order to give a 7-foot channel throughout this reach, in conjunction with the dams, was originally estimated to be about 2,200,000 cubic yards. But little of this dredging has been done.

The amount estimated to be necessary to complete the work above outlined is $587,500. Were this sum available for operations during the coming fiscal year the larger part of the work, except the dredging, could be completed before its end.

The Government owns two good dredges, built expressly for operations in this part of the river, but on account of insufficiency of appropriations these lie idle for at least seven months in the year. All this time they are deteriorating, and when funds become available and they are called into use about the lock-sites considerable amounts must each time be expended to put them in even a reasonable state of repairs. The steamboats, barges, and other parts of the plant provided for this work are similarly situated. If the work were pushed to completion all this outfit would become available for some other locality, and thus save the Government the cost of duplication and continual repairs.

When this work is completed it will then be practicable for the large steamers belonging to the Upper and Lower Mississippi, the Ohio, and Missouri rivers to come with their unbroken cargoes to within 100 miles of Lake Michigan. All this can be brought about by an expenditure on the part of the Government of less than $600,000.

The Illinois River, from the western terminus of the Illinois and Michigan Canal at La Salle to Copperas Creek, about 80 miles below, has been improved by the State of Illinois by means of two locks and dams similar to those in process of construction by the United States on the river below. From La Salle to Joliet the Illinois and Des Plaines rivers have been carefully surveyed, and plans and estimates of cost for their improvement to the same navigable capacity as the river below have been made and submitted to Congress. The report on this project submitted by Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. Army, may be found in the Chief of Engineer's Report for 1884, page 1958. The estimated cost of improving this reach of the river is $3,433,562. The distance is 64 miles and the fall 100 feet.

Congress has now before it the engineering data showing the feasibility and cost of a water communication between the Mississippi River and a point 30 miles distant from navigable water leading into Lake Michigan sufficiently commodious for the commercial and military exigencies of the country, and from this point to the lake perfectly practical routes over which the line can be constructed are known to exist. It only remains for Congress to provide the means for making the necessary surveys and estimates of cost for continuing this work from Joliet to Lake Michigan, when it will have the engineering features of the whole subject before it in a shape necessary for intelli-

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gent legislation. I estimate that about $10,000 will be sufficient to defray the expenses of the necessary surveys and examinations and preparation of the plans and estimates of costs of the work.

The United States and the State of Illinois have long been committed to the project of opening a water communication between the Mississippi River and the northern lakes of capacity sufficient for the wants of commerce and for the exigencies of our national defense, should these ever arise. The amount expended by the United States to the end of the present fiscal year in carrying out this project is $680,633.42, exclusive of $62,359.80 expended on the foundation of the Copperas Creek Lock, which was afterwards turned over to the State. The cost of the locks and dams built by the State of Illinois at Copperas Creek and Henry was $747,747.

The distance by this route from the Gulf of Mexico to the southern end of Lake Michigan is about 1,620 miles. When the projected improvement of the Illinois River below Copperas Creek, on which we are now working, has been finished, more than 1,520 miles of this distance will be available for the water transportation of commerce in bulk between these points. Pushing this improvement through to the lake, the connecting line will be formed which will join the northern lakes with the vast net-work of navigable rivers whose waters flow into the Gulf of Mexico on a scale to a certain degree commensurate with the importance of the commerce that will be affected by it. The mere fact that such a route is available will serve as a wholesome regulator to the rates that would be exacted by other methods of transportation were this one not in existence. Besides the immense commercial advantages that may be expected from the completion of the project, there are military and naval exigencies that might easily arise where it would figure as a prominent factor in the problem of our national defenses. From whatever point we look at the subject there is nothing local or sectional in it. It is true that all the work to be done happens to be in the State of Illinois. The benefits to be derived belong to the nation at large. It is fortunate, too, that at this time the subject is unencumbered by any phase of a political character. The problem of connecting Lake Michigan with the Mississippi River by a commodious water-way, that could be used for commercial, military, and naval purposes, has received attention from our most thoughtful statesmen from the day of Albert Gallatin to the present.

The qestion of enlarging the Illinois and Michigan Canal from Joilet to Chicago, Ill., to a capacity equal to the low-water capacity of the improved Illinois River has been discussed at some length by Gen. J. H. Wilson in a report to the Chief of Engineers, U. S. Army, published as House Ex. Doc. No. 16, Fortieth Congress, first session. Since the date of that report the conditions which affected the problem in its most essential features have materially changed. Additional engineering data that we are not now in the possession of have become a matter of absolute necessity, and must be collected and compiled before all the facts necessary to a thorough understanding of the subject can be laid before Congress. The Board of Engineers appointed under provisions of the river and harbor act approved August 5, 1886, to examine and report upon the Illinois and Michigan Canal and the proposed Hennepin Canal, says in its report (House Ex. Doc. No. 79, Forty-ninth Congress, second session) that "the water-way from Chicago to Grafton, on the Mississippi River, is a most important one, and when completed there is little doubt that it will richly pay for itself in the reduction and regulation of freights." These remarks are concurred in by the Chief

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of Engineers in his letter submitting this report to the Secretary of War. In the same report the Board remarks:

In view of the possibilities of the case, it would appear that whatever enlargement of the canal is made from Joliet northward should not be carried further than the "Sag," a point whence the line of the canal could be easily diverted to a more favorable terminus.

The Secretary of War, in laying this matter before Congress, remarks upon this point:

In this connection another question is suggested by the report of the Board of Engineers. At present the canal has its northern terminus in the South Branch of the Chicago River, about 5 miles from Lake Michigan. This branch runs through the central business portion of Chicago, and is crossed by numerous draw-bridges At present these bridges are a great impediment to navigation and to the land traffic of Chicago. If this river becomes the only outlet to the large commerce that may follow the opening of this new route of transportation between the Mississippi River and Lake Michigan, another outlet for the canal will be necessary, and economy and convenience may demand another channel to the waters of Lake Michigan. As to the cost of such a change, should it be necessary, we have no knowledge, no preliminary surveys of the country, with a view to the constructing of a new route to the lake, having been made.

In my report to the Chief of Engineers dated February 10, 1886, supplementary to that of Maj. W. H. H. Benyaurd, Corps of Engineers, on the subject of the Hennepin Canal, published in House Ex. Doc. No. 117, Forty-ninth Congress, first session, I have the honor to state:

Before taking steps looking to the enlargement of the Illinois and Michigan Canal, in the interests of commerce, or as a military expedient, the advisability is suggested of ascertaining whether or not some route can be found from Joliet to Lake Michigan at a point where better facilities can be provided for handling the large commerce of this section. It is thought by some that a practical route exists between the valleys of the Des Plaines and Calumet rivers, along which a canal such as will accommodate the largest vessels using the improved Illinois River can be constructed, at a cost less than that estimated for the enlargement of the Illinois and Michigan Canal from Joliet to Chicago.

Before definitely locating that portion of this route which is to lie between Joliet and Lake Michigan, and which will involve in its construction the expenditure of a very considerable amount of money, every possible route should be examined, and every engineering phase of the problem should be considered. For these reasons I venture to respectfully suggest the advisability of calling the attention of Congress to the necessity for making available the sum of $10,000; as much thereof as may be necessary to be expended in examinations and surveys between the southern end of Lake Michigan and the Des Plaines River at or near Joliet, Ill., and on the preparation of plans and estimates of cost of constructing, along the most practical route so determined, a water-way having sufficient capacity to accommodate the same class of vessels and commerce that the present improved condition of the Illinois River is designed to accommodate.

It is proper for me to invite attention in this report to the fact that since the adjournment of the last session of Congress the legislature of the State of Illinois has passed an act ceding to the United States the locks and dams at Henry and Copperas Creek. The following is the text of the act:

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That the locks and dams in the Illinois River built by the State of Illinois, and all the privileges and appurtenances belonging thereto, are hereby ceded to the United States upon the following express conditions, viz: The acceptance of this grant shall be construed as an agreement on the part of the United States to make the necessary improvements (to be determined by United States engineers) for a complete water-way for steam navigation (water 7 feet deep) from the Mississippi River to Lake Michigan, by way of the Illinois River, the Desplaines River, the Illinois and Michigan Canal, or

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in part by each, or otherwise, as may be deemed most practical by said engineers. A further condition is, that when said improvements shall be completed, the water-way opened thereby shall be maintained for commercial purposes, to be used by all persons without distinction, subject to such rules and regulations as Congress may prescribe.

SEC. 2. Whereas the subject-matter of this bill is now pending before Congress; an emergency exists; therefore this act shall take effect and be in force from and after its passage.

Approved by the governor May 31, 1887.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1889.

The amount estimated for the fiscal year ending June 30, 1889, is $400,000, and will be applied to purchasing materials and completing the dam at La Grange and the lock and dam at Kampsville, and dredging the river in accordance with the existing project.

Money statement.

July 1, 1886, amount available		$4,360.43
Amount appropriated by act approved August 5, 1886		112,500.00
		116,860.43
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$52,319.26	
July 1, 1887, outstanding liabilities	22,805.79	
		75,125.05
July 1, 1887, amount available		41,735.38
Amount (estimated) required for completion of existing project		587,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		400,000.00

Abstract of proposals received and opened May 20, 1887, for furnishing and delivering the iron and steel necessary for the lock-gates, valves, etc., at La Grange Lock, on the Illinois River, Illinois.

No.	Names and addresses of bidders.	Price per pound.		
		Steel.	Wrought iron.	Cast-iron.
		Cents.	*Cents.*	*Cents.*
1	Williams, White & Co., Moline, Ill	5.4	3.9	4.8
2	Builders' Iron Foundry, Providence, R. I	6.87	5.45	4.45
3	Vierling, McDowell & Co., Chicago, Ill	6.5	9.	6.25

Abstract of contracts for Illinois River in force during the fiscal year ending June 30, 1887.

Contractors.	For—	Date.	Expires.	Remarks.
Sanger & Moody	Stone	Nov. 8, 1884	Oct. 31, 1885	Stone all cut; delivery not completed.
Do	do	Sept. 15, 1886	Oct. 1, 1886	
Williams, White & Co	Irons for lock-gates, etc.	May 31, 1887	Aug. 30, 1887	

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COMMERCIAL STATISTICS.

The portion of the Illinois River that is at present being improved by the United States is in the customs district of New Orleans.

The following statistics were taken from the report of the Saint Louis Board of Trade for 1885:

Freight received at Saint Louis, Mo., via Illinois River	tons..	88,010
Freight shipped from Saint Louis, Mo., via Illinois River	do....	5,175
Boats arrived at Saint Louis from Illinois River	number..	199
Boats departed from Saint Louis for Illinois River	do....	208

It should be borne in mind that this exhibit of the amount of commerce at present on the river gives no indication whatever of the amount that will avail itself of this route when the whole project is completed, nor does it in the least give any indication of the importance of the improvement.

REPORT UPON THE ACQUISITION AND IMPROVEMENT OF THE ILLINOIS AND MICHIGAN CANAL, AND THE CONSTRUCTION OF THE HENNEPIN CANAL.

WAR DEPARTMENT,
Washington City, January 10, 1887.

The Secretary of War has the honor to lay before the Congress a report of a Board of Engineers, made in accordance with a provision of the river and harbor act of August 5, 1886, which is as follows, viz:

The Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army, whose duty it shall be to examine in all their relations to commerce the Illinois and Michigan Canal and the proposed Hennepin Canal, to consider their value and all other matters connected with their usefulness to navigation, and shall report upon the acquisition and improvement of the Illinois and Michigan Canal and the construction of the Hennepin Canal. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon; and $15,000, or so much thereof as may be necessary, is hereby appropriated for this purpose: *Provided*, That nothing in this paragraph shall be construed as committing the Government to the said improvement.

The report of the Chief of Engineers thereon and other documents and plans are annexed to the report of the Board of Engineers. This report has for its subject the general project of providing a navigable water-way between Lake Michigan and the Mississippi River. The project can be readily understood by dividing the distance between Chicago and the Mississippi into three several sections and considering each separately: (1) From Chicago, by the Illinois and Michigan Canal, to La Salle; (2) from La Salle, by the Illinois River, to Hennepin, and thence to the Mississippi River; and (3) from Hennepin, by the proposed Hennepin Canal, to points on the Mississippi River at or above Rock Island.

(1) The State of Illinois, by an act passed in 1882, ceded to the United States the Illinois and Michigan Canal, its right of way, and all lands and appurtenances belonging thereto, for canal purposes, and for the purpose of making and maintaining an enlarged canal and water-way from Lake Michigan to the Illinois and Mississippi rivers. The same to be accepted by the United States "upon the express condition that the canal shall be enlarged in such manner as Congress shall determine, and be maintained as a national water-way for commercial purposes."

The United States, upon accepting this act, would be bound to enlarge and maintain the canal as a national water-way for commercial purposes. The report of the Board of Engineers shows that to enlarge the

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canal between Joliet and La Salle, and provide for an increased navigation, equal to that contemplated by the improvements in progress on the Illinois River, between La Salle and its junction with the Mississippi, would require an expenditure of money greater than the cost of improving the river itself between Joliet and La Salle. If such is the case, the river route should be improved as recommended. The State of Illinois, however, before acceptance by the United States, should release the United States from the condition imposed by the act to enlarge and maintain the canal as it now exists, as a more suitable and cheaper water-way can be otherwise obtained.

In this connection another question is suggested by the report of the Board of Engineers. At present the canal has its eastern terminus in the south branch of the Chicago River, about 5 miles from Lake Michigan. This branch runs through the central business portion of Chicago, and is crossed by numerous draw-bridges. At present these bridges are a great impediment to navigation and to the land traffic of Chicago. If this river becomes the only outlet to the large commerce that may follow the opening of this new route of transportation between the Mississippi River and Lake Michigan, another outlet for the canal will be necessary, and economy and convenience may demand another channel to the waters of Lake Michigan. As to the cost of such a change, should it become necessary, we have no knowledge, no preliminary surveys of the country with a view to the constructing of a new route to the lake having been made.

The conclusion, therefore, would seem to be clear that the United States should not be bound to enlarge the existing canal between La Salle and Joliet, if the improvement of the Illinois River between those places will furnish a cheaper mode of communication, nor to maintain any portion of the canal the abandonment of which may become necessary or desirable in the future. In that event, the United States should have full liberty to change the route.

(2) Between La Salle and Hennepin the Illinois River supplies a satisfactory water-way. From Hennepin to the junction of the Illinois with the Mississippi, locks and dams are now in progress of construction to render it navigable. A portion of these have been built, and are now building, by the United States. But the improvements at Henry and Copperas Creek were made by the State of Illinois, which now exercises control and collects tolls on the commerce passing over this portion of the river. I agree with the Board of Engineers that a complete transfer of these improvements by the State of Illinois should accompany the cession of the canal. The United States should control the entire river, and all the improvements, rights, and privileges connected therewith; and the obligations to be assumed by the Government should be clearly defined before an acceptance can be considered advisable.

(3) From the great bend of the Illinois, where it turns in a southerly direction, the second artificial line of water communication has been projected. This line, which runs in a general westerly direction "from a point on the Illinois River at or near the town of Hennepin by the most practicable route to the Mississippi River at or above the city of Rock Island," is known as the Hennepin Canal, surveys for which were authorized by act of Congress of August 2, 1882.

The proposed canal runs from Hennepin westerly about 25 miles to the summit level between the two rivers. From this point three diverging lines have been surveyed and considered by the engineers, which strike the Mississippi River near Rock Island, Watertown, and Albany,

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respectively. Watertown is 7 miles and Albany 28 miles above Rock Island. The route terminating at Albany is known as the Marais d'Osier route. Reports of these surveys and estimates of cost are appended to the report..

Upon examination of the report of the Board it is evident that a commercial benefit to the country would result from the completion of these navigable water-ways between Lake Michigan and the Mississippi River. While that great river may be reached by the Illinois and Michigan Canal and the Illinois River, the mouth of the latter is so far south that these water-ways do not afford sufficient or convenient communication with the Upper Mississippi. The report of the engineers shows clearly that the construction of the Hennepin Canal is feasible, and that its benefits to commerce would be great. Whether they would be so great as to justify the cost is a matter for Congress to decide, and to assist this decision the statistics of commerce in the Northwest and the estimates for the construction of the canal are herewith presented.

The question of its western terminus is discussed in the report and all sides are fully presented in the accompanying papers. Of the three routes proposed the Board favors the Marais d'Osier route, terminating at Albany. General Newton, while holding the office of Chief of Engineers, declared himself in favor of the Rock Island route; and there are advocates of the third, or Watertown route.

Although from the report of the Board it would appear that the Marais d'Osier route, regarded as an engineering question alone, is preferable, yet in view of the existing routes of travel and transportation, and from military considerations, I am inclined to coincide with the opinion of General Newton in favor of the Rock Island route.

WILLIAM C. ENDICOTT,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1886.

SIR: I have the honor to submit herewith a copy of the report of the Board of Engineer officers constituted in compliance with the requirements of the river and harbor act of August 5, 1886, to examine, in all their relations to commerce, the Illinois and Michigan Canal and the proposed Hennepin Canal; to consider their value and all other matters connected with their usefulness to navigation, and to report upon the acquisition and improvement of the Illinois and Michigan Canal and the construction of the Hennepin Canal.

In submitting this report for your consideration I beg leave to state, in further compliance with the requirements of the above act, that I concur in the opinions of the Board regarding the utility and importance to navigation and commerce of a water-way from Chicago to Grafton at the mouth of the Illinois River, but would call attention to the act of the State of Illinois of April 28, 1882, offering to cede the Illinois and Michigan Canal from La Salle to Chicago as being silent concerning the locks and dams at Henry and at Copperas Creek, constructed for the improvement of the navigation of Illinois River, the retention of which by the State would deprive the United States of the control of 88 miles of river where tolls are charged by the State. With reference to the conditions in this act of cession regarding the enlarge-

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ment of the canal, I would remark that the locks and dams that have been, and are to be, built by the United States below La Salle have been projected with a view to a steam-boat navigation of the first class, and the project looks to a continuation of navigation upon the same scale between La Salle and Joliet, and since the cost of an enlargement of the canal between these points would, it appears, be greater than that of the improvement of the river itself, a river route between those points should be adopted.

I also concur in the opinions of the Board respecting the value and usefulness to navigation and commerce of a water-route from Chicago to the Mississippi such as the proposed Hennepin Canal, but I can not fully concur in their views as to its proper terminus on the Mississippi.

Although the Marais d'Osier route, with a terminus near Albany, forms the cheapest and shortest line, and involves less lockage, it is by no means clear, in the present condition of the commercial relations existing on the two sides of the river, that it would be the preferable route.

Very respectfully, your obedient servant,

J. C. DUANE,
Brig. Gen., Chief of Engineers.

Hon. WM. C. ENDICOTT,
Secretary of War.

REPORT OF BOARD OF ENGINEERS APPOINTED UNDER PROVISIONS OF THE RIVER AND HARBOR ACT APPROVED AUGUST 5, 1886, TO EXAMINE AND REPORT UPON THE ILLINOIS AND MICHIGAN CANAL AND THE PROPOSED HENNEPIN CANAL.

SIR: The river and harbor act of August 5, 1886, contained the following clause, viz:

> The Secretary of War is authorized and directed to appoint a Board of three engineers from the United States Army, whose duty it shall be to examine, in all their relations to commerce, the Illinois and Michigan Canal and the proposed Hennepin Canal, to consider their value and all other matters connected with their usefulness to navigation, and shall report upon the acquisition and improvement of the Illinois and Michigan Canal and the construction of the Hennepin Canal. The said Board shall report to the Secretary of War, who shall lay its report before Congress at its next session, together with the views of himself and the Chief of Engineers of the United States Army thereon; and $15,000, or so much thereof as may be necessary, is hereby appropriated for this purpose: *Provided*, That nothing in this paragraph shall be construed as committing the Government to the said improvement.

The Board of Engineers constituted under the above law has the honor to submit the following report, viz:

At an early date in the history of Illinois the connection of Lake Michigan with the Mississippi was considered, and in 1822 and 1827 grants of land were made by the United States to Illinois to aid in the construction of such a water-way. (See Appendix No. 1.)

Under this grant the State of Illinois completed a canal (with locks 110 feet by 18 by 6 feet) reaching from Chicago to La Salle, on the Illinois River, a distance of 97 miles, the general direction of the canal being southwest. From La Salle to the mouth of the Illinois River at Grafton is 223 miles, and this part of the river has a system of locks and dams now carried well toward completion, which will give 7 feet of water at the lowest stages. Two of these locks and dams, at Henry and Copperas creeks, have been built in whole or in part by the State of Illinois, which manages them and charges tolls for their use. The others

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are being built by the United States. When they are completed they will furnish a large water-way from the Mississippi, at Grafton, Ill., to La Salle.

The State of Illinois offers to cede the Illinois and Michigan Canal from La Salle to Chicago to the United States, on the condition that the United States shall enlarge and maintain it.

The United States has not accepted the offer, and were she to do so it would place the two ends of the water-way from Chicago to Grafton in the possession of the United States, while Illinois would control the dams and locks now in her possession at Henry and Copperas creeks, where tolls are charged. If the United States is to assume any new responsibilities, she should have control of the whole water-way, and not merely of its two end. The enlargement of the Illinois and Michigan Canal with locks of the size proposed for the Hennepin Canal is desired by those interested in the Hennepin Canal. An enlargement to a very much greater size might enable the city of Chicago to send a much larger amount of sewage into the Chicago end of the canal than is now pumped into it, and would give a great water-power at Lockport, where the canal falls to a level much below that of Lake Michigan.

The water-way from Chicago to Grafton, on the Mississippi River, is a most important one, and when completed there is little doubt that it will richly pay for itself in the reduction and regulation of freights.

But it does not give a direct water route from Lake Michigan to points on the Mississippi above Keokuk, a route that has long been desired. Hence, at an early date it was proposed to connect the bend in Illinois River near Hennepin, about 15 miles below La Salle, where the Illinois and Michigan Canal terminates, with a point on the Mississippi River at or above Rock Island, by means of a canal. Such a canal, called the Hennepin Canal, is feasible at a reasonable cost, and need not exceed 64 miles in length, while the distance from Hennepin down the Illinois River to Grafton, and then up the Mississippi River to Rock Island, is about 486 miles. The saving in distance by water via a Hennepin Canal between Chicago and points on the Mississippi above Rock Island is thus seen to be over 400 miles. This general statement of the situation having been given, it remains to consider that one of the two routes on which the Board has been directed to report, namely, the route from Chicago via the Illinois and Michigan Canal and Illinois River to Hennepin, and thence via the proposed Hennepin Canal to the Mississippi River at or above Rock Island.

The law under which the Board is acting requires it to "examine, in all their relations to commerce, the Illinois and Michigan Canal and the proposed Hennepin Canal, to consider their value and all other matters connected with their usefulness to navigation."

Their principal relation to commerce is as freight carriers and freight-rate regulators, and their usefulness to commerce will depend on the rates at which freight can be carried on them. The general consideration of these questions does not depend on the details of location and construction, and hence they may fitly be considered before the detailed discussion of the two canals is taken up.

Few things are more remarkable than the great reduction in the cost of transportation which has taken place in the last few years between Chicago and New York.

The following table, for which the Board is indebted to Mr. Whitney, Acting Chief of Bureau of Statistics, shows that freight rates by water between these cities have been reduced in 1885 to about one-fifth their amounts in 1868, and all rail freights to about one-third.

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TABLE 1.—*Average freight charges per bushel for the transportation of wheat from Chicago to New York during the years 1868 to 1885, inclusive.*

[From the Annual Reports on Foreign Commerce, 1883, 1884, 1885.]

Calendar years.	Average rates per bushel.			Calendar years.	Average rates per bushel.		
	By lake and canal.*	By lake and rail.	By all rail.		By lake and canal.*	By lake and rail.	By all rail.
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
1868	25.3	29.0	42.6	1877	7.5	15.8	20.3
1869	24.1	25.0	35.1	1878	10.1	11.4	17.7
1870	17.5	22.0	33.3	1879	13.0	13.3	17.3
1871	21.6	25.0	31.0	1880	13.2	15.7	19.7
1872	26.6	28.0	33.5	1881	8.6	10.4	14.4
1873	19.2	23.9	33.2	1882	8.7	10.9	14.6
1874	14.2	16.9	28.7	1883	8.40	11.5	16.5
1875	11.4	14.6	24.1	1884	6.59	9.9	13.2
1876	9.7	11.8	16.5	1885	4.55	9.06	14.0

* Including Buffalo transfer charges and tolls.

The table also shows that the rates by water have been in each year from 25 to 50 per cent. less than by all rail, and indicates sufficiently how powerful a regulator of railroad freights from Chicago to New York the water-way between those cities has been. The estimate that railroads have of such water-ways and of their value is seen when a system like that of the Vanderbilts, reaching from New York to Chicago, puts steamers on the lakes as rivals to its own roads.

Definite ideas as to cost of transportation may be obtained from the following data, derived from Poor's Railroad Manual for 1886, viz:

TABLE 2.—*New York Central and Hudson River Railroad.*

Year.	Through freight east.	Through freight west.	Total way freight.	Earnings per ton-mile.	Expenses per ton-mile.
	Tons.	*Tons.*	*Tons.*	*Cents.*	*Cents.*
1880	2,077,626	357,453	8,097,000	0.879	0.541
1881	2,056,583	436,497	9,098,000	0.783	0.563
1882	1,523,907	582,800	9,223,000	0.738	0.601
1883	1,452,159	361,161	9,079,000	0.910	0.650
1884	1,182,088	312,078	8,717,000	0.830	0.620
1885	1,146,687	297,210	9,087,000	0.680	0.540

TABLE 3.—*Lake Shore and Michigan Southern Railroad.*

Year.	Freight forwarded from Chicago.	Net rate per ton-mile.	Cost per ton-mile.
	Tons.	*Cents.*	*Cents.*
1880	1,084,000	0.75	0.43
1881	1,184,000	0.62	0.41
1882	900,000	0.63	0.41
1883	904,000	0.73	0.45
1884	812,000	0.65	0.43
1885	929,000	0.55	0.40

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TABLE 4.—*Michigan Central Railroad.*

[Average rate per ton-mile.]

Year.	Cents.	Year.	Cents.
1880	0.84	1883	0.83
1881	0.72	1884	0.65
1882	0.77	1885	0.56

The three railroads just cited have their rates regulated during the summer, at least in part, by the rates on a water-way connecting the two ends of the roads, and, as stated by Mr. Albert Fink, the regulation as regards grain extends to the winter season, since if railroad rates were increased too much during the winter the grain would be stored to await the fall of rates at or before the opening of navigation. It should be remembered that rates per ton-mile in the preceding table are the average rates for all the freight moved, and as local freights between non-competing points is charged habitually at a higher rate than through freight, the through rates must have been considerably less than the average rates given in the preceding tables. Thus, according to the report of the State engineer of New York for 1883, through freight rates on the New York Central and Hudson River Railroad for fourth-class freight in 1882 were 0.56 cent per ton-mile, while for way freight the rate was 0.87 cent.

An examination of the preceding tables for three great roads shows that in six years, from 1880 to 1885, the rates charged varied between 0.91 and 0.55 cent per ton-mile, while for these years the cost to the Lake Shore road varied between 0.40 and 0.45 cent per ton mile, the charges varying between 0.75 and 0.55 cent per ton-mile.

Mr. Albert Fink stated (report Senate Select Committee on Interstate Commerce, Forty-ninth Congress, first session, 1886):

> The average cost on the roads between here (New York) and Chicago, which are operated the cheapest, is about 24 cents per 100 pounds, which includes general expenses, but does not allow anything for interest. * * * I do not think grain can be hauled for much less than about 20 cents, including general expenses; and the mere cost of movement can not be less than 15 cents. The cost of returning empty cars must be charged to this service, and the lowest actual cost is not reimbursed by a charge of 12 cents per 100 pounds.

Taking the distance from New York to Chicago as 912 miles, a rate of 10 cents per 100 pounds, is 0.245 cent per ton-mile; 12 cents is 0.294 cent per ton mile; 15 cents is 0.37 cent per ton-mile; 20 cents is 0.49 cent per ton-mile, and 24 cents is 0.58 cent per ton-mile.

The statement of Mr. Fink, who is a high authority on these subjects, are for averages for railroads between New York and Chicago. The Lake Shore Railroad expenses are lower than 20 cents for 100 pounds; this must be due to its gentle grades, superior facilities, and cheap coal. The statement of Mr. Fink, as well as the rates of the roads above quoted, strongly influenced by competing water-ways, and in the later years by railroad wars, show that average railroads can not transport freight in large quantities, and for a long time, at less than 0.5 cent per ton-mile; or in exceptionally favorable cases at about 0.4 cent per ton-mile; these prices not including interest on bonds or dividends on stock. Mr. Fink, in the testimony already quoted from, says:

> It may be estimated that upon an average of $1 earned by all the railroads in the United States for a certain service 40 cents are required to pay 4½ per cent. interest on bonds and stock; 35 cents to pay the mere movement expenses above referred to; and, say, 25 cents to pay for the maintenance of the roadway and the general expenses of the organization.

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The average freight charges on New York Central, Michigan Central, and Lake Shore railroads between 1880 and 1885, inclusive, varied between 0.80 and 0.65 cent per ton-mile. Taking 40 per cent of this for interest there is left but about 0.40 cent per ton-mile out of which future reductions in freight rates must come.

Much reduction in this does not seem possible. Nor does it seem possible that under the most favorable circumstances railroads can profitably convey large amounts of freight at less than 0.40 cent per ton-mile, while for most roads this figure would rise to 0.5 or 0.6 cent.

Let us compare this rate with that at which grain can be carried on canal-boats, on sail-vessels, and on steam-boats. The report of the Chicago Board of Trade for 1885 gives the freight rates on wheat by sail and by steam vessels from Chicago to Buffalo during 1885, as follows:

TABLE 5.—*Grain freights by lake and Erie Canal.*

[The following were the current rates of freight on wheat and corn from Chicago to Buffalo, Oswego or Kingston (sail), and to Montreal (steam); also to New York by lake and Erie Canal, for each week during the season of navigation, 1885.]

Week ended—	Wheat per bushel.			Week ended—	Wheat per bushel.		
	To Buffalo.	Erie Canal, Buffalo to New York.	Chicago to New York (lake and canal) including Buffalo charges.		To Buffalo.	Erie Canal, Buffalo to New York.	Chicago to New York (lake and canal) including Buffalo charges.
	Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*
April 4	.....	.....	.....	August 8	.....	4⅜	.....
April 11	.....	.....	.....	August 15	.....	4⅜	.....
April 18	3½	.....	.....	August 22	1¾	5¼	4¾
April 25	2	5¾	.....	August 29	.....	5	.....
May 2	2½	.....	.....	September 5	.....	4¾	.....
May 9	2¾	5½	.....	September 12	1¾	4¾	3¾ to 4¼
May 16	2¾	4⅞	5	September 19	.....	4¾	.....
May 23	1¾ to 2	4⅜	.....	September 26	.....	4¼	.....
May 30	.....	4	.....	October 3	.....	4¼	.....
June 6	1⅜	4¼	.....	October 10	.....	4⅜	.....
June 13	.....	4¼	.....	October 17	.....	4¼	.....
June 20	.....	3⅞	.....	October 24	.....	5¼	5¼
June 27	.....	3¾	.....	October 31	.....	.....	.....
July 4	1⅜	4	.....	November 7	.....	.....	.....
July 11	.....	4	.....	November 14	.....	.....	.....
July 18	.....	3¾	.....	November 21	.....	.....	.....
July 25	1 to 1¼	3⅞	3⅜				
August 1	.....	3¾	.....	Average	2.0	4.5	4.6

From this table it is seen that between April 18 and September 12, 1885, eleven rates are given between Chicago and Buffalo by sail, whose average is 2 cents per bushel, the least rate being 1 cent. Calling the distance from Chicago to Buffalo by water 900 miles, 2 cents per bushel is at the rate of 0.08 cent per ton-mile.

Between May 9 and November 5, 1885, the average freight by steam vessels was 2.5 cents per bushel, or 0.1 cent per ton-mile. Table 5 gives also through rates from Chicago to New York, which are considerably lower than the partial rates just quoted, ranging from 3¼ to 5¼ cents per bushel, and which average 4.6 cents.

If 1.6 cents of this be taken as the lake part, and 3 cents as the canal part, there results 0.07 cent per ton-mile on the lake, and 0.22 cent for the canal and river rate. These through rates are considerably lower than the sum of the partial rates in the same table.

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From April 25 to October 24, 1885, the average freight from Buffalo to New York via the Erie Canal, a distance of 500 miles, was 4.5 cents per bushel, corresponding to 0.33 cent per ton-mile, the lowest rate being 3¾ cents per bushel. But these were local rates, and through rates were lower.

Mr. Sweet, State engineer of New York, states (Transactions American Society Civil Engineers, February, 1885):

For the past four years the average grain rates from Chicago to New York during the season of navigation have been by rail, 14.9 cents; by lake to Buffalo and thence by rail to New York, 12.1 cents; and by lake and canal to New York, 9.9 cents per bushel.

The large propellers of the lakes have, however, during this period, found a profit in carrying grain from Chicago to Buffalo at 2 cents a bushel, while the cost by canal from Buffalo to New York, though the distance is only half as great, without tolls, but including the cost of transfer, has at the same time been more than 4 cents per bushel.

From the statement of Mr. Sweet it is seen that the freight rates for 1885 are lower than for the average of the preceding four years.

Mr. J. D. Van Buren, jr., formerly State engineer of New York (Transactions American Society Civil Engineers, March, 1885), estimates the cost of transporting freight from Buffalo to New York via Erie Canal, when animal power is used, at 0.32 cent per ton-mile; when steamer and consort are used, at 0.31 cent. Mr. E. P. North, in the same transactions, gives the average freight per ton from Buffalo to Albany, excluding tolls, from 1878 to 1881, as $1.17 or 0.33 cent per ton-mile.

The following table, for which the Board is also indebted to Mr. Whitney, shows that the water rates sank lower in 1885 than in previous years:

TABLE 6.—*Average freight rates for the transportation of wheat.*

[Annual Report of Bureau of Statistics on Foreign Commerce.]

Year.	Rates per bushel.*						
	Average ocean rate from San Francisco to Liverpool.	All rail rate from Chicago to New York and ocean steamer rate from New York to Liverpool.			Lake Erie Canal and Hudson River rate from Chicago to New York and ocean steamer rate from New York to Liverpool.		
		Rail rate.	Ocean steamer rate.	Total.	Lake, canal, and Hudson River.	Ocean steamer rate.	Total.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1878	30.25	17.7	15.22	32.92	10.1	15.22	25.32
1879	29.93	17.3	12.40	29.70	13.0	12.40	25.40
1880	38.67	19.7	11.76	31.46	13.2	11.76	24.96
1881	46.28	14.4	8.16	22.56	8.6	8.16	16.76
1882	33.89	14.6	7.76	22.36	8.7	7.76	16.46
1883	25.47	16 5	9.08	25.58	8.4	9.08	17.48
1884	20.78	13.2	7.18	20.38	6.59	7.18	13.77
1885		14.0	6.11	20.11	4.55	6.11	10.66

*Considerable differences will be observed between the sum of the average rail and ocean steamer rates and the sum of the average lake, Erie Canal, and ocean steamer rates between Chicago and Liverpool, such differences ranging from 4.3 cents to 6.5 cents. This is explained as follows: First, the lake, Erie Canal, and Hudson River rates are only for the season of inland navigation, viz: From May to November, when the rail rates are usually lowest; second, the rail rates in the table are schedule rates, which have from time to time been departed from during railroad wars. The exact average of the rail rates which have actually been charged can not, therefore, be stated. On the other hand, the lake, Erie Canal, and Hudson River rates are subject to a small addition for marine insurance, amounting to about ⅛ cent.

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The State Engineer of New York (Interstate Commerce Report, page 172) gives 0.27 cent per ton-mile as the average rate of canal freights in 1884.

The following table, derived from report of Senate Select Committee on Interstate Commerce, page 246, shows the present relation of the Erie Canal and the trunk lines as grain and flour carriers to New York City:

TABLE 7.

Year,	Total receipts of grain and flour at New York, Philadelphia, Boston, Baltimore, and Montreal.	Percentage received at New York by canal.	Percentage received at New York by rail.
	Bushels.		
1878	293,000,000	22	29
1879	332,000,000	17	31
1880	341,000,000	20	28
1881	267,000,000	14	37
1882	211,000,000	15	38
1883	244,000,000	17	33
1884	225,000,000	17	34

From this table it is seen that for these years the canal has carried to New York from four to seven tenths as much grain and flour as all the trunk lines combined, and hence that its rates must powerfully influence those of the trunk lines.

Another evidence of the influence of the water-way between Chicago and New York on freight rates may be had by comparing average freight rates per ton-mile on two great roads running east from Chicago and in immediate competition with the lakes with two great roads running west and northwest from Chicago without water competition.

The data are from Poor's Railroad Manual, 1886, for 1885.

TABLE 8.

Year.	Lake Shore Railroad, average rates per ton-mile.	Michigan Central Railroad, average rates per ton-mile.	Milwaukee and Saint Paul Railroad, average rates per ton-mile.	Chicago and Northwestern Railroad, average rates per ton-mile.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1881	0.62	0.72	1.70	1.47
1882	0.63	0.77	1.48	1.48
1883	0.73	0.83	1.39	1.43
1884	0.65	0.65	1.29	1.31
1885	0.55	0.56	1.28	1.20

This table shows that rates charged on the first two roads running out of Chicago for five years past have been about one-half those charged on the other two. A part of this difference must be due to the regulating effect of the water-way through the lakes.

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This effect again appears in the following table from the report of trade of Minneapolis, December 31, 1885:

TABLE 9.—*Tariff rates per* 100 *pounds on grain and flour from Chicago and Minneapolis to New York during the year* 1885.

Date.	From Chicago.	From Minneapolis.	Date.	From Chicago.	From Minneapolis.
Jan. 1 to Mar. 10	.25	.42½	Aug. 28 to Sept. 1	.15	.30
Mar. 10 to Apr. 28	.20	.37½	Sept. 1 to Sept. 2	.12	.27
Apr. 28 to May 1	.15	.32½	Sept. 2 to Sept. 9	.12½	.27½
May 1 to May 16	.15	.30	Sept. 9 to Sept. 16	.10	.25
May 16 to June 5	.12½	.27½	Sept. 16 to Sept. 18	.12	.27
June 5 to July 1	.13	.28	Sept. 18 to Oct. 1	.10	.25
July 1 to July 13	.15	.30	Oct. 1 to Nov. 23	.20	.35
July 13 to Aug. 14	.20	.35	Nov. 23 to Dec. 1	.25	.40
Aug. 14 to Aug. 17	.15	.30	Dec. 1 to Dec. 31	.25	.42½
Aug. 17 to Aug. 28	.20	.35			

The shortest distance by rail from Minneapolis to Chicago is 420 miles, and thence to New York is 912 miles. It is seen that for about half the period of navigation the tariff rates were as low or lower from Chicago to New York than from Minneapolis to Chicago. It might be supposed since Minneapolis is but 150 miles from Duluth, from which point the water rates to New York are about the same as from Chicago, that the Duluth route would act as a regulator on rates to Chicago. But (testimony on interstate commerce, page 1250) rail rates to Duluth were 12½ cents per 100 (June 24, 1885) for 150 miles, while they were but 15 cents to Chicago, 420 miles. Mr. Pillsbury testified that he thought the Duluth road would make its rate 7½ cents, but was compelled by the other roads to keep it up.

From the above table it is seen that September 9 to 16, 1885, the rate from Minneapolis to New York was 25 cents per 100 pounds. If at this time the rate from Minneapolis to Duluth was 12½ cents, then at the tariff rate it cost as much to carry a bushel of wheat from Minneapolis to Duluth by rail, 150 miles, as to carry it from Duluth to New York.

For the last few years the competition between the trunk lines has been so fierce and prices have been so low that it is not probable lower freight rates by rail between Chicago and New York will soon be seen.

Summing up the preceding discussion, we may take 0.50 cent per ton per mile as about the minimum rate at which grain in large quantities can be carried by rail at a profit on the average railroad, and 0.40 cent for the most favored road; about 0.27 cent as the rate for the Erie Canal; about 0.08 cent as the rate at long distances on the lakes.

These figures sufficiently show that railroads can not successfully compete with the water-way from Chicago to New York, nor with the Erie Canal, in the carriage of large freights of low value per pound, except in cases where rapid transit is an important element. It is often asserted that the railroads have destroyed the importance of the Erie Canal as a grain carrier. Table 7, already given, shows the incorrectness of such an idea.

Having considered freight rates by water and by rail east from Chicago, it is now necessary to examine rates on the Mississippi River lines. If the Hennepin Canal were built, much of the freight passing through it would also move on the Mississippi River, and the rates at which freight could be carried on that river would largely influence the use of

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the canal. Mr. J. F. Barker, general freight agent of the Saint Louis and Saint Paul Packet Company, informs the Board (September 30, 1886), that the rates on grain that have prevailed for the last four years from Saint Paul to Rock Island are 12½ cents per hundred, and from Saint Paul to Saint Louis, 15 cents. Mr. E. M. Dickey, superintendent of the "Diamond Jo Line" (October 4, 1886), states:

> Our average rate from Saint Paul to Rock Island on this commodity (grain) would be about 10 cents per 100 pounds, and from Saint Paul to Saint Louis 12½ cents to 15 cents. * * *

Average rate on freight shipped from Rock Island in 1885 was 15 cents per 100 pounds.

Average rate on freight shipped to Rock Island in 1855 was 11 cents per 100 pounds.

In giving the averages of freight rates to Rock Island, he adds:

> These averages are of course on business largely local, and in most cases of course in small lots. There has been little through business to or from Rock Island for some years. Large shipments of through freight would materially reduce this average.

The rate of 12½ cents per hundred from Saint Paul to Saint Louis, a distance of 700 miles by river, is 0.40 cent per ton-mile and 15 cents is 0.48 cent.

From the accompanying letter from Maj. A. Mackenzie (Appendix No. 2) it will be seen that 3½ feet of water may be expected from Saint Paul to Rock Island during the season of navigation, and that 6 feet may be expected about one-half of that season. The end now in view in improving the Upper Mississippi is to obtain 6 feet from Saint Paul to Saint Louis. Even as the river now is, with a depth almost always exceeding 4 feet, its freedom from locks and its great width allowing high speeds, there can be no doubt if a large amount of freight offered itself for carriage that greater facilities in handling would develop themselves and that competition would reduce the existing minimum rate of 0.40 cent to that of the Erie Canal, or to about 0.30 cent per ton-mile.

When the low-water depth of 6 feet is obtained from Saint Paul to the western terminus of Hennepin Canal, barges loaded with 400 to 600 tons could be used in place of the canal-boats of 240 tons on the Erie Canal.

The locks on a canal fix the size of the boats using it. On the Erie Canal the locks are 110 feet by 18 feet by 7 feet. The canal-boats can carry 240 tons. On the proposed Hennepin Canal and the enlargement of the Illinois and Michigan Canal, the locks are to be 170 feet by 30 feet by 7 feet, and to admit barges that can be loaded to 600 tons. With the Upper Mississippi improved to 6 feet depth, rates through it and the canals to Chicago, without toll, should sink to 0.20 cent per per ton-mile.

These considerations lead the Board to the conclusion that if a large business should be developed, grain can be carried by the canal from the Mississippi to Chicago at 0.20 to 0.30 cent per ton-mile. The distance by the shortest rail route from Saint Paul to Chicago is 410 miles. The distance by the proposed water route from Saint Paul to Chicago is about 530 miles. At 0.2 cent per ton-mile the freight would be $1.06 per ton, or 4.7 cents per hundred pounds.

It has already been seen that in the summer of 1885 rail rates on grain from Saint Paul to Duluth were 12½ cents and to Chicago 15 cents per 100 pounds. Hence, even if the cost of transportation on a waterway from Saint Paul to Chicago, much larger than the Erie Canal, were

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as great as on the Erie Canal for some years past, say about 0.30 cent per ton-mile and one-half greater than has been taken above, this would only raise it to 7 cents per 100 pounds from Saint Paul to Chicago. Such a rate would compel a large reduction in the rail rates from Saint Paul to Duluth and Chicago on grain. Grain, however, is not the only freight which can be profitably transported by water.

The report of the Duluth Board of Trade, 1885, gives 372,000 tons of coal as received there by lake in 1884, and 595,000 in 1885, freight rates from Buffalo being in some cases as low as 25 cents per ton. From the report of the Chicago Board of Trade, 1885, page 158, it appears that 863,000 tons of coal were shipped from there by the Chicago and Northwestern, the Milwaukee and Saint Paul, and the Chicago, Burlington and Quincy railroads.

How much of this coal goes west to or beyond the Mississippi is unknown, but there is undoubtedly a large amount.

The Chicago, Milwaukee and Saint Paul tariff rate of December 1, 1885, on soft coal in car-loads from Chicago to the Mississippi at Savannah, was $1.75 per ton. It could be carried via the proposed Hennepin Canal, if in large quantities, at 50 cents.

The use of anthracite coal along the Mississippi and west of it is reported to be rapidly increasing. If the freight on it from Chicago to the Mississippi could be reduced by $1 per ton, this increase would doubtless be still more rapid.

Any freight whose value per pound is small and which does not need rapid transit would be affected in the same way as coal.

Thus far the water route from Chicago to the Mississippi has only been considered as affecting rates from points on the Mississippi to points on the lakes. The great railroads running west from Chicago reach far into the grain regions west of the Mississippi, and were the water-ways constructed, they might make rates to the Mississippi so nearly equal to those to Chicago that shippers would find no advantage in shipping to the Mississippi and thence by water to Chicago.

The railroads would have power to do this; but the danger of hostile legislation would make the wisdom of such a policy doubtful.

It therefore seems probable that the influence of this water-route would be felt far west of the Mississippi.

The Board, therefore, reports that in its opinion the water-way from Chicago to the Mississippi River will be valuable and useful to navigation; that it will give a water-way from Chicago to Saint Paul, over which freights of low cost per pound and not demanding the most rapid transit can be transported at rates much below existing rates by rail, and that the influence of this water-way in reducing rates of freight will probably extend west of the Mississippi.

The Board is also of the opinion that the benefits to the people affected by it will exceed the cost of its construction, as specified hereafter.

The general conclusions of the Board as to the "usefulness to navigation" of this water-way having been given, it remains to consider the details of the two parts, namely, the Hennepin Canal and the Illinois and Michigan Canal.

HENNEPIN CANAL.

The water-route from Lake Michigan to the Mississippi River is, from Chicago, through the Illinois and Michigan Canal, 97 miles, to La Salle,

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on the Illinois River, thence 17 miles down the Illinois River, and thence to the Mississippi River by the proposed Hennepin Canal. A few miles below La Salle and 3 miles above Hennepin, Ill., the Illinois River, which above has been flowing westward toward the Mississippi River, makes a sudden bend to a nearly southerly course, almost parallel for many miles to that of the Mississippi River, and at a distance from it of 50 or 60 miles.

Many years ago it was proposed to connect the Mississippi River in the vicinity of Rock Island with the Illinois River, at or near Hennepin, by means of a canal. The history of the surveys of different routes may be found in a report by Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. A., published in the Report of the Chief of Engineers, U. S. A., for 1883. From this report it appears that Mr. J. O. Hudnutt made a survey in 1866, for private parties, of a canal-route from Hennepin to Watertown, on the Mississippi River, with a feeder from Rock River, at Dixon. An estimate was made of $4,500,000, for a canal 60 feet wide at the water-surface, 6 feet deep, and with locks 150 feet by 21 feet.

In 1870 the Government first had a survey made by Mr. G. P. Low, under General Macomb's directions. The route for canal and feeder was nearly that followed by Mr. Hudnutt. The estimated cost of a ship-canal 8 feet deep and 160 feet wide at the water-line, with locks 350 feet by 75 feet, with feeder 7 feet deep and 140 feet wide, was $12,479,693.

In 1874 an estimate was made of $4,541,000 for a canal along the same route, but with locks only 170 feet by 30 feet. Under the act of Congress passed August 2, 1882, a resurvey was made under the direction of Maj. W. H. H. Benyaurd, several routes being included.

Beginning on the Illinois River, 1¾ miles above Hennepin, the routes were common for 25 miles, to where the Dixon feeder enters the canal, the best route for ascending 205 feet from the Illinois River to the summit being through the valley of Bureau Creek. From the feeder west diverging routes were surveyed to near Albany, on the Mississippi River, via the Marais d'Osier, and to Watertown, on the Mississippi. These routes were called the Marais d'Osier and the Watertown routes, respectively.

The length of each route is 64 miles. From the 58th mile on the Watertown route a line to Rock Island was surveyed. It enters Green River at the 59th mile, follows it to its junction with the Rock River, then follows the latter to Milan, when it crosses the low point separating the Mississippi from the Rock River. Its total length is 74.5 miles. The common lockage in ascending from the Illinois River to the summit level is 205 feet. In going west the descending lockage by the Marais d'Osier route is 75 feet; by the Watertown route 86 feet; by the Rock Island route 101 feet.

Supplementary surveys, made in 1885-'86, were reported March 6, 1886, by Maj. T. H. Handbury, Corps of Engineers, U. S. A. (Ex. Doc., page 117, House Report, Forty-ninth Congress, first session). These additional surveys related to modifications of the Watertown and Rock Island and routes. A part of the new Watertown route lies a few miles to the north of the old route running via Penny's Slough. When this new line strikes Penny's Slough the new Rock Island line leaves it, following the Rock River to the vicinity of Milan and then crossing to the Mississippi River.

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The following table, extracted from Major Handbury's report, gives the estimated cost of the different routes:

TABLE 10.

Marais d'Osier route, distance 64 miles:	
Estimated cost of construction of canal, including right of way	$5,811,367.50
Estimated cost of maintenance and ordinary repairs annually	88,600.00
Outfit of dredges, etc	36,000.00
Watertown route (via Green River), distance 65.2 miles:	
Estimated cost of construction of canal and feeder, including right of way	7,207,646.88
Estimated cost of maintenance and ordinary repairs annually	91,245.00
Outfit of dredges, boats, etc	36,000.00
Watertown route (via Penny's Slough), distance 64.9 miles:	
Estimated cost of construction of canal and feeder, including right of way	6,306,552.83
Estimated cost and maintenance and ordinary repairs annually	90,000.00
Outfit of dredges, boats, etc	36,000.00
Rock Island route (via Green River) revised, distance 74.5 miles:	
Estimated cost of construction of canal and feeder, including right of way	6,709,836.00
Estimated cost and maintenance and ordinary repairs annually	94,820.00
Outfit of dredges, boats, etc	36,000.00
Rock Island route (via Penny's Slough and Rock River), distance 77 miles:	
Estimated cost of construction of canal and feeder, including right of way	6,524,052.61
Estimated cost of maintenance and ordinary repairs annually	84,000.00
Outfit of dredges, boats, etc	36,000.00
The length of the feeder from Rock River at Dixon is 37 miles, and its estimated cost, included in the above	1,654,117.50

The estimates are for a canal 80 feet wide at the water-surface, 7 feet deep, and with locks 170 feet by 30.

It will be seen from the brief history now given that many surveys have been made. Although further surveys would necessarily be made before adopting a final and exact location for construction, it is not probable that routes much more favorable can be found.

There seems no doubt as to the proper location of the eastern end of the Hennepin Canal.

It is approximately fixed by the great bend in the Illinois River and the valley of Bureau Creek, which enters the Illinois River near Hennepin, furnishes a route by which the canal can climb up to the summit, 205 feet above the Illinois River.

Of the various routes from this summit level that by Marais d'Osier is the cheapest. But as strong interests desire a different route, an examination of the principal ones is necessary.

It is evident that the canal should be so located as to give, on the whole, the cheapest transportation to the aggregate freight that is to pass through it. Its through freight eastward will probably be derived from the portion of the Mississippi between Saint Paul and Keokuk, which are 508 miles apart. Keokuk is 124 miles below Rock Island and 149 miles from the mouth of the Illinois River. In view of the greater ease in moving freight down-stream rather than up, and of the more facile navigation in the Illinois River than in the Hennepin Canal, Keokuk may be taken as the southern point on the Mississippi from which freight might go to Chicago through the Hennepin Canal. Below this point the Illinois River would be used.

The northern limit is, of course, Saint Paul, 384 miles by river from Rock Island.

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Even if as much freight would pass through the Hennepin Canal from the lower half of this stretch of 508 miles from Keokuk to Saint Paul as from the upper, the western terminus of the canal should be as near the middle of the stretch as praticable, which would carry the terminus far above Rock Island. In fact, if the canal accomplishes what is hoped for it, the larger part of its business will come from points above Rock Island. This larger business should then have the shortest route to Chicago, and it would be unjust to lengthen its route to accommodate a small part of its business. The two points which have strong claims for the location of the western terminus of the canal are Rock Island for the Rock Island route, and a point 2 miles below Albany for the Marais d'Osier route. Albany is about 30 miles above Rock Island, and the route from points above it to Chicago is 40 miles shorter by the Marais d'Osier route than by the Rock Island route.

If the Rock Island terminus were selected, all business from up the river would have in this additional 40 miles to descend the Rock Island Rapids and then lock up 26 feet to get back to the level of the Marais d'Osier route.

For freight bound west the objection to the Rock Island route would be that it would give to all freights for points above Albany the increase in lockage and distance already mentioned, and 30 miles of the increased distance would be up-stream and over the Rock Island Rapids.

If the canal is to do a large business, the bulk of its freight should not be subjected to this detour past Rock Island.

In this discussion as to termini it has been tacitly assumed that the canal will do a business large enough to develop all the terminal facilities it may need for transacting its business.

If its business were a local one and a small one, as would be the case if Rock Island, Moline, and Davenport freight formed a considerable portion of its whole freights, there would be a decided advantage in having its terminus at Rock Island, which could easily supply terminal facilities and give it local trade. But in that case it would lose its strongest claim for being built by the United States.

The Watertown route has its terminus intermediate between the other two; situated on the rapids, its approaches are bad, and this route from Saint Paul to Chicago is 21 miles longer than the Marais d'Osier route.

In view of all the circumstances of the case the Board prefers the Marais d'Osier route. This route is 64 miles long between the Illinois River near Hennepin and the Mississippi River near Albany.

The dimensions proposed for it by Major Benyaurd, and which seem judicious, are, locks 170 feet by 30 feet by 7 feet; width of canal at water-surface, 80 feet; ascending lockage from Illinois River to summit level, 205 feet by 23 locks, descending lockage to the Mississippi River near Albany, 75 feet by 8 locks; feeder from Dixon, Ill., 37 miles long.

It seems not improbable that surveys for the precise and final location may indicate a line near the junction, with the feeder somewhat further north, thus shortening the feeder and perhaps slightly reducing the cost.

Such surveys would be made after the construction of the canal was decided on.

Estimated cost of the Hennepin Canal, $5,811,367.50.

(For further details see Major Benyaurd's report in Report of Chief of Engineers for 1883.)

Objections have been raised to the Marais d'Osier route on account of the overflow at its western ends, at times, by the Mississippi.

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These objections are unimportant in comparison with the advantage of this route.

ILLINOIS AND MICHIGAN CANAL.

The following condensed history of the inception and construction of the Illinois and Michigan Canal is mainly taken from Appendix A to the report of General J. H. Wilson and Mr. William Gooding upon the survey of the Illinois River, dated December 17, 1867. (See Annual Report of the Chief of Engineers, 1868, pages 454 and 455.)

Very soon after Illinois became a State steps were taken to secure the construction of a canal "between the navigable waters of the Illinois River and Lake Michigan," and as early as 1822 Congress, by act approved March 30 of that year, authorized the State "to survey and mark through the public lands of the United States the route of the canal connecting the Illinois River with the southern bend of Lake Michigan," and 90 feet on each side of said canal were reserved from sale for canal purposes.

This reserve was doubtless made mainly for the purpose of future enlargement, as it is not to be supposed that the State, in its infancy, would make an improvement of sufficient capacity to meet the wants of the country when its resources should be developed.

By act of the general assembly of the State of Illinois approved February 14, 1823, a board of commissioners was appointed and instructed to have the route of the canal surveyed and the cost of the work estimated and reported to the general assembly.

They were further instructed "to invite the attention of the governors of the States of Ohio and Indiana, and, through them, the legislatures of their respective States, to the importance of improving and connecting the navigation of the Wabash and Maumee rivers by canal communications," thus indicating in some degree the extent of the water communications of which this particular canal was to form part.

In 1825, in accordance with this act, five plans were submitted by the board of commissioners, the estimates varying from $639,000 to $716,000.

By act of Congress approved March 2, 1827, the United States—

Granted to the State of Illinois, for the purpose of aiding the said State in opening a canal to unite the waters of Illinois River with those of Lake Michigan, a quantity of land equal to one-half of five sections in width on each side of said canal, and reserving each alternate section to the United States, to be selected by the Commissioner of the Land Office, under the direction of the President of the United States, from one end of the said canal to the other; and the said lands shall be subject to the disposal of the legislature of the said State, for the purpose aforesaid, and no other: *Provided*, That the said canal, when completed, shall be and forever remain a public highway for the use of the Government of the United States, free from any toll or other charge whatever, for any property of the United States, or persons in their service passing through the same: *Provided*, That said canal shall be commenced within five years, and completed in twenty years, or the State shall be bound to pay to the United States the amount of any lands previously sold, and that the title to purchasers under the State shall be valid.

* * * * * * *

This grant amounted to 284,000 acres.

By act of Congress approved March 2, 1833, the foregoing act was amended to permit the State of Illinois to use and dispose of the lands granted "for the purpose of making a railroad instead of a canal, as in said act contemplated;" and the time for commencing and completing was extended five years.

Section 2 of an act of Congress approved August 29, 1842, authorized the governor of the State of Illinois "to cause to be selected, from any

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of the unsold public lands in that State, not subject to the right of preemption, the quantity of 5,760 acres, in lieu of" lands theretofore selected under the act of March 2, 1827, "but which had been sold and patented to individuals by the United States before the location by the said State had been approved."

By act of Congress approved August 3, 1854, the governor of the State of Illinois was "authorized to cause to be selected the balance of the land to which that State is entitled under the provisions of the act of the second of March, eighteen hundred and twenty-seven," from any public land in said State subject to private entry, to complete an amount equal to one-half of five sections in width on each side of the canal.

Somewhat over 32,000 acres were selected under this authority.

It will be seen from the foregoing that Congress has, by successive acts through a series of years, recognized the importance of the Illinois and Michigan Canal.

By act of the general assembly of the State of Illinois approved January 22, 1829, a new board of canal commissioners was authorized to commence the construction of a canal and to dispose of the lands granted by the United States to provide means with which to carry on the work.

Under the proviso of section 2 of said act surveys were made in 1830 by a party of engineers acting under the War Department. Their investigations, however, were mostly confined to the practicability of the canal, supply of water, etc.

In 1833 other surveys and estimates were made under authority of the State, as provided in the act of the general assembly approved February 15, 1831, and the engineers estimated the cost of constructing a canal 40 feet wide and 4 feet deep at $4,043,000.

It was not until 1836, however, that efficient measures were adopted for the prosecution of the work.

Under act of the general assembly approved January 9, 1836, a new board of canal commissioners was organized, with authority to construct the canal, and Mr. William Gooding was appointed engineer.

An accurate survey was made and estimates furnished by him of the probable cost of a canal 6 feet deep, 60 feet wide at surface, 36 feet wide at bottom in earth excavation, and 48 feet in rock, with locks 110 feet long, 18 feet wide, and having 6 feet of water on their miter-sills.

Portions of the work were put under contract in June of that year, and fair progress was made on the whole line until 1841, when, for the want of adequate means on the part of the State, the work was gradually suspended until March, 1843, when all operations ceased.

The act of the general assembly approved February 21, 1843, known as the "trust law," provided for the completion of the canal and the payment of the canal debt.

It was not until 1845, however, that operations were resumed, but after resumption the work was carried to completion, and the canal brought into use in the spring of 1848.

It was intended that the canal should extend from Bridgeport to Ottawa, but the southwestern terminal point was finally located in the vicinity of La Salle, the total length being 97.24 miles.

The capacity of the canal, as completed by the canal trustees, was the same throughout as that fixed when work was commenced in 1836, but a material change was made in the reference of the bottom of the canal on the summit division to bring the cost of the canal within the means provided for its completion. The original intention was to cut down the summit between Lake Michigan and Lockport, and draw through

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this "deep cut" a supply of water from the lake sufficient for canal purposes. Instead of this, the canal was completed for about 26½ miles on a level, averaging 9 feet above the original bottom, and water supplied for the summit by means of the Calumet feeder, 16½ miles long, and by pumping-works at Bridgeport.

The abandonment of the original plan of the "deep cut" involved the necessity of constructing the Kankakee feeder, which is received into the canal just above the junction of the Kankakee and Des Plaines rivers.

The Chicago River, from which the summit level received a considerable portion of its water supply through the pumping-works at Bridgeport, has always been the receptacle of the sewage of the city. With the growth of the city the foulness of the river increased to such a degree as to demand the adoption of some plan for its amelioration.

This resulted in the act of the general assembly of the State of Illinois approved February 16, 1865, entitled "An act to provide for the completion of the Illinois and Michigan Canal upon the plan adopted by the State in 1836," the object of which was to obtain, by cutting down the summit level, a flow of water from Lake Michigan through to the Illinois River, thus cleansing Chicago River. The work of deepening the summit level was commenced in December, 1865, and continued until July, 1871, when it was completed, the average vertical cut being about 8 feet; that is to say, from 2 feet above city datum (city datum is low water of 1847 in Lake Michigan) to 6 feet below. It was intended that the bottom from Bridgeport to Lockport should have a fall of 3 feet.

In the course of time, from caving and sliding banks and from other causes, the canal prism was considerably reduced and the flow of water greatly diminished. The water that passed Lockport, Joliet, and other points on the canal finally became so offensive that, in 1881, a joint resolution was passed by the legislature of Illinois, under which the city of Chicago was compelled to erect, at Bridgeport, pumping-works of a capacity of at least 60,000 cubic feet per minute.

The lift at Bridgeport varies with the level of Lake Michigan.

DESCRIPTION OF THE CANAL AS IT NOW EXISTS.

The Illinois and Michigan Canal commences at Bridgeport, on the South Branch of Chicago River, 5 miles from Lake Michigan by the course of the stream.

It extends thence in a southwesterly direction 97.24 miles, and terminates on the Illinois River near La Salle, thus completing a most important water-route between Lake Michigan and the Mississippi River at a point only about 40 miles above Saint Louis.

The canal was intended to be 60 feet wide at the water surface, 48 feet wide on the bottom, with locks 110 feet long, 18 feet wide, and having a depth of 6 feet on their miter-sills. Cross-sections of the canal taken from recent surveys show an increased width at the water-surface, caused by caving and sliding in of the side slopes.

Entrance to the canal at Bridgeport is effected through a lock, the lift of which varies with the fluctuations in the level of Lake Michigan.

All levels on the canal are referred to the Chicago city datum, which is the low water of 1847.

From Bridgeport the summit level of the canal extends to Lockport, a distance of 29½ miles, where Lock No. 1 is located, with a lift of 10.30 feet. One mile beyond No. 1 Lock No. 2, with a lift of 9.65 feet, is reached, and in another mile Locks No. 3 and 4, with lifts respectively of 9.85 and 9.90 feet.

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A short distance below No. 4 the canal enters the Des Plaines River, which is used for a distance of 2 miles. Lock No. 5, having a lift of 10.10 feet, is located on the right bank of the Des Plaines, 1¼ miles below No. 4.

The distance from Bridgeport to Lock No. 5 is 33¼ miles, and the surface of the water in the pool above it is 42.08 feet, the combined lifts of the locks above being 39.70.

The canal leaves the river at a point some 3,000 feet below Lock No. 5 by means of a guard-lock, the lift of which is given as 0.125 foot. It then continues to the town of Channahon (45th mile), where Lock No. 6, with a lift of 11.87 feet, takes it into the Du Page Pond.

Lock No. 7, with a lift of 3.90 feet, takes the canal from the Du Page River, and at the 48th mile it is joined by the Kankakee feeder.

Three-quarters of a mile below the aqueduct the Des Plaines and Kankakee unite to form the Illinois.

Crossing the Au Sable River, Lock No. 8, with lift of 6.55 feet, is reached at the 53d mile.

At Marseilles, near the 75th mile, the canal passes through two locks, the lifts of which are 833 feet each. Fox River is crossed 7 miles beyond, and at a further distance of 1½ miles the canal receives the Fox River feeder.

Lock No. 11, lift 9.75 feet, is located at the 82d mile; Lock No. 12, lift 9.85 feet, at the 85th mile; Lock No. 13, lift 6.40 feet, at the 94th mile; and Locks Nos. 14 and 15, with lifts, respectively, of 13.75 and 11.52 feet, at the 96th mile, the southern boundary of the city of La Salle. Below this the canal is connected with the Illinois River by a steam-boat channel about 1 mile in length.

The fall from water surface of the pool above Lock No. 5 to present low-water-surface in Illinois River at La Salle is 100.25 feet, the combined lifts of the locks being 100.47 feet.

It must be noted that the terminus of the canal is now in the pool created by the dam at Henry, on the Illinois River, and that the present low-water surface is 4.4 feet above the low-water level at the time the canal was completed.

Although not a part of the canal, yet forming an extension of it, and under the management of the Board of Canal Commissioners, the improvements at Henry and Copperas creeks should be included in any description of the Illinois and Michigan Canal.

These improvements consist at each place of a dam, by means of which a navigable pool is formed in the river above, the dams being passed by locks.

The dam at Henry is 6 feet 4 inches high and raises the low-water surface, 38 miles above, at La Salle, 4.4 feet.

That at Copperas Creek, about 60 miles below, is 6 feet 7 inches high, and raises the low-water surface immediately below the Henry Dam 2 feet.

The locks are each 350 feet long, 75 feet wide, with 7 feet of water on the miter-sills. The system is intended to give a 6-foot navigation, and tolls are levied by the State of Illinois upon the passing commerce.

The United States contributed the sum of $62,359.80 toward the construction of these works.

In further extension of this system the navigation of the Illinois River below Copperas Creek is being improved by the United States by a dam and lock at La Grange and another at Kampsville.

These are well advanced in construction, and it is estimated that they can be completed by an additional expenditure of about $700,000.

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FURTHER CONSIDERATIONS.

When these improvements shall have been completed there will be good navigation from La Salle to the Mississippi River for the largest class of Western steam-boats drawing 6 feet of water, thus making it one of the most important thoroughfares for heavy freight in either direction.

The estimated cost of extending this system from La Salle to Joliet is $3,433,562, thus bringing it to within 34 miles of Chicago.

The question of the enlargement of the Illinois and Michigan Canal from Joliet to Chicago, to accommodate this commerce without transshipment, has been discussed at length by General J. H. Wilson (see Ex. Doc. No .16, House of Representatives, Fortieth Congress, first session).

Since the date of that report the conditions have materially changed, and in a new discussion of the subject other routes than the one contemplated by General Wilson should be considered.

THE RELATION OF THE CANAL TO COMMERCE.

Including the commerce through the locks at Henry and Copperas creeks, which, though on the Illinois River, really constitute an extension of the Illinois and Michigan Canal, the amount transported during the five years ending with 1885 was 4,547,071 tons, thus showing traffic to an extent little suspected by those who have not looked into the subject.

This commerce comprised a great variety of products, prominent among them being flour, salt, corn, oats, wheat, coal, ice, sand and gravel, lumber, stone, and general merchandise.

Parallel to the canal and throughout the greater part of the distance from Chicago to La Salle, along its very banks, private enterprise has built the Chicago, Rock Island and Pacific Railroad.

The two routes are, therefore, in direct and close competition between all points on the canal, with resulting benefit to both producers and consumers.

It has been demonstrated time and again that available water-routes always lessen the cost of transportation by competing land-routes.

This influence is so widespread, extends in so many ways, that the full effect is indeterminable.

Probably no higher authority exists upon this subject than Mr. Albert Fink, who has testified before a Congressional committee—

> That water routes not only control the tariffs of their immediate railroad competitors at points where they can render like service to the same people, but their influence reaches directly and indirectly the remotest parts of the country.

Limiting the discussion, however, to the immediate effect of the canal upon rates by rail, reference is made to the statement found on page 233, Part I, Senate Report 307, Forty-third Congress, first session, that—

> The freight charges on the Chicago, Rock Island and Pacific Railroad is only 8 cents per 100 pounds from Henry to Chicago, between which points there is water competition, while the rate from Tiskilwa, only 12 miles further west than Henry, and beyond the effect of canal competition, is 15 cents per 100 pounds, or nearly as much for 12 miles as for 100 miles.

Comments upon such facts is quite unnecessary.

Assuming that the commerce of the canal is carried an average distance of one-third its length, the traffic above referred to may be con-

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sidered as 1,516,000 tons transported 96 miles, with a saving of $1.40 per ton in freight charges, or in the short period of five years a total of $2,122,400 to be distributed amongst the producers and consumers, many of these being at points so remote that they may never have even heard of the Illinois and Michigan Canal.

But the direct benefit is not limited to the freight carried by canal. It is not improbable that an equal or even greater amount of freight carried by the railroad was affected, and had the advantage of the lower rate compelled by the existence of the water route; if so, the total given above should be at least doubled to obtain the actual saving in charges.

It is a matter of very little consequence whether the canal carries any freight or not so long as the fact that it is there, and in readiness for the purpose, affects the charges by rail, reducing them to such extent that shippers prefer land transportation.

Neither does it seem to injuriously affect the competing railroad in this case, since the stock is quoted to-day (October 25, 1886) at $125 per share.

COST OF THE CANAL.

According to General J. H. Wilson (Annual Report of the Chief of Engineers, 1868, page 455), the total original cost of the canal was $6,409,509.95.

But Mr. Joseph Utley, president of the Board of Canal Commissioners, in a communication dated March 7, 1874, addressed to "Hon. Wm. Windom, chairman of the Senate Committee on Transportation," states that "the total cost of the canal was $6,557,681.50" (see page 93 of appendix to Senate Report 307, Part I, Forty-third Congress, first session.)

This is confirmed by the statement included in the following correspondence.

ILLINOIS AND MICHIGAN CANAL,
SUPERINTENDENT'S OFFICE,
Lockport, Ill., March 1, 1879.

DEAR SIR: The original cost of the Illinois and Michigan Canal has been called in question, and stated to be $16,000,000. For the purpose of aiding the legislature in considering the question whether the canal is worth preserving, I desire you to prepare a full and careful statement from the records of the general office at Lockport, showing the original cost of the canal, how much has been received from the sale of lands granted for the canal by the General Government, and how much have been the net revenues of the canal to date.

Respectfully yours,

WM. THOMAS,
General Superintendent.

D. C. JENNE, Esq.,
Chief Engineer.

CANAL OFFICE,
Lockport, Ill., March 1, 1879.

DEAR SIR: At your request, contained in your communication of this date, I have made a careful examination of the books and reports on file in this office, and find that the total cost of construction of the Illinois and Michigan Canal has been as follows:

Amount expended by the canal commissioners	$5,133,062.21
Amount expended by the canal trustees	1,424,619.29
Total	6,557,681.50

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I have also examined the account of sale of canal lands and the receipts therefrom, and find as follows:

Sales by canal commissioners prior to act of February 23, 1843	$932,407.91
Sales by State trustees after act of February 23, 1843	219,656.88
Sales by canal trustees after act of February 23, 1843	4,706,482.68
Sales by canal commissioners, after expiration of trust, to December 1, 1878	27,492.21
Total receipts for canal lands	5,886,039.68

I have also examined the accounts of net earnings of the canal and find as follows:

Net receipts over expenses of operating by canal trustees	$2,392,145.95
Net receipts over expenses of operating by canal commissioners	541,545.79
Total net earnings	2,933,691.74
Add receipts from canal lands, as above	5,886,039.68
Total receipts	8,819,731.42
Deduct cost of construction of canal, as above	6,557,681.50
Receipts over cost of canal	2,262,049.92

Which is respectfully submitted.

DANIEL C. JENNE,
Chief Engineer.

I have examined the above figures and find them to be correct.

WM. MILNE,
Chief Clerk.

WILLIAM THOMAS, Esq.,
General Superintendent Illinois and Michigan Canal.

Between December, 1865, and July, 1871, the canal was deepened by excavating the "bench" or summit level between Bridgeport and a point 2 miles above Lockport. The average vertical cut was 8 feet; that is, from 2 feet above the city datum at Chicago to 6 feet below.

This work was done by the city of Chicago under the provisions of an act of the legislature of Illinois approved February 16, 1865.

Authorities differ as to the actual cost of this work paid by the city of Chicago.

Mr. William Thomas, formerly superintendent of the canal, gives it as $3,306,658.89.

The board of public works of the city of Chicago, in their report for 1871, state it at $3,330,883.71, which is probably correct.

To reimburse the city of Chicago for the cost of this excavation, section 4 of the act of February 16, 1865, gave the city a lien upon the canal and its revenues to the extent of $2,500,000 and interest, and provided for payment out of the earnings of the canal.

After the great fire in Chicago the legislature of Illinois, for the purpose of relieving this lien, and at the same time aiding the distressed city, on the 20th October, 1871, appropriated the sum of 2,955,340, with interest until paid.

This expenditure was not included in the foregoing statement of the cost of the canal, but the Board sees no good reason for omitting it, and therefore includes it in the following revised statement, viz:

Amount of original cost of construction	$6,557,681.50
Amount refunded to the city of Chicago	2,955,340.00
Total cost	9,513,021.50

This sum is too small, however, by whatever amount has been paid by the State as interest under the provision of section 4 of the act of

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October 20, 1871. Concerning this amount (if any) the Board has not received any information.

According to the foregoing statement the net receipts down to December 1, 1878, were	$8,819,731.42
Since that time, according to the annual reports of the board of canal commissioners, the expenses have exceeded the receipts to December 1, 1885, by	14,651.13
Net receipts to December 1, 1885	8,805,080.29
Amount received from land sales to December 1, 1878	5,886,039.68
Amount received from land sales between December 1, 1878, and December 1, 1886, as shown by the annual reports of the canal commissioners	6,668.28
Total to December 1, 1885	5,892,707.96

It thus appears that up to and including November 30, 1885, the State of Illinois has expended on the canal the sum of at least $3,620,313.54 more than has been received from the sale of the lands granted, or $707,941.21 more than the net receipts from all sources of revenue, interest account not included.

The sources of revenue are tolls, leases of water-power, leases of "90-foot strip" and lots, ice leases, sales of lots and lands, sales of "spoil-bank" stone, sales of clay, and miscellaneous.

The following table exhibits the business of the canal for twenty-six years:

TABLE 11.—*Statement of number of canal-boats running, of miles run, of clearances issued, and of tons transported on the Illinois and Michigan Canal during twenty-six years, viz, from* 1860 *to* 1885, *inclusive.*

Date.	Clearances issued.	Boats running.	Miles run.	Tons transported.	Date.	Clearances issued.	Boats running.	Miles run.	Tons transported.
1860	3,926	201	235,684	367,437	1873	*4,743	172	328,174	849,533
1861	6,339	194	415,509	547,295	1874	*4,296	152	288,075	712,020
1862	7,044	211	474,976	673,500	1875	*3,554	142	259,878	676,025
1863	5,810	240	418,713	619,599	1876	*4,049	145	302,024	691,943
1864	4,527	228	300,340	510,286	1877	*4,008	145	272,788	605,912
1865	3,907	228	360,614	616,140	1878	*4,299	140	293,335	598,792
1866	5,488	230	406,784	746,815	1879	*4,458	136	304,191	669,559
1867	4,183	209	357,623	746,954	1880	*4,536	133	320,009	751,360
1868	4,128	216	345,169	737,827	1881	*4,459	133	316,435	826,133
1869	4,524	219	285,050	817,738	1882	*4,055	132	335,710	1,011,287
1870	2,905	270	242,650	685,870	1883	*3,780	132	306,618	935,575
1871	3,523	186	278,948	629,975	1884	*4,204	134	325,431	956,721
1872	*5,018	173	334,820	783,041	1885	*3,990	†135	304,664	827,355

* Includes clearances at Henry and Copperas creek.
† Of this number 27 are steam canal-boats and 8 are tugs.

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The following table exhibits the business in detail for the season of 1885, and is inserted for the purpose of showing the varied character of the freight transported:

TABLE 12.—*Statement of articles cleared Illinois and Michigan Canal and locks at Henry and Copperas Creek for the year ending November* 30, 1885.

Articles.	Canal.	Lock at Henry.	Lock at Copperas Creek.
Flour ..... barrels..	103, 680	652	.....
Lime:			
Common ..... do....	468	44	.....
Hydraulic ..... do....	144	15	.....
Oil ..... do....	68	19	.....
Salt ..... do	893	101	255
Corn ..... bushels..	1, 954, 993	126, 000	14, 042
Oats ..... do....	805, 546	13, 500	1, 000
Potatoes ..... do....	303	.....	.....
Rye ..... do....	18, 885	1, 844	.....
Wheat ..... do....	835, 020	2, 064	4, 953
Agricultural implements ..... pounds..	500	.....	.....
Carpenter and joiner's work ..... do....	22, 160	.....	.....
Coal ..... do....	14, 318, 500	496, 000	488, 000
Clay ..... do....	47, 971, 975	.....	.....
Drainage pipe ..... do....	2, 881, 055	.....	.....
Empty barrels ..... do....	44, 400	4, 270	1, 470
Furniture, household ..... do....	16, 390	.....	.....
Hay and straw ..... do....	218, 000	.....	70, 000
Iron, all kinds ..... do....	165, 156	.....	.....
Ice ..... do....	60, 562, 000	84, 080, 000	4, 400, 000
Merchandise, including dry goods, groceries, hardware, cutlery, crockery, and glassware, pounds	287, 422	90, 358	12, 994, 551
Meal ..... pounds..	171, 650	.....	.....
Machinery ..... do....	74, 350	600	100, 000
Nails and spikes ..... do....	15, 850	.....	.....
Sand and gravel ..... do....	49, 280, 100	.....	.....
Seeds ..... do....	63, 710	.....	.....
Wagons and other vehicles ..... do....	53, 150	3, 000	.....
All other articles not enumerated ..... do....	1, 350, 785	77, 119	10, 000
Brick ..... number..	1, 870, 500	.....	.....
Lath ..... do....	4, 202, 100	.....	.....
Passengers ..... do....	.....	.....	1, 918
Posts and rails ..... do....	40, 032	.....	.....
Railroad ties ..... do....	27, 645	.....	28, 880
Shingles ..... do....	17, 142, 500	8, 000	.....
Flooring ..... feet..	189, 711	.....	.....
Lumber (board measure) ..... do....	24, 646, 375	.....	34, 660
Siding ..... do....	47, 738	.....	.....
Stone:			
Dimensions, rough ..... cubic yards..	59, 523	4	.....
Dressed ..... do....	5, 157	.....	.....
Riprap ..... do....	35, 767	.....	.....
Rubble ..... do....	213, 579	.....	.....
Wood ..... cords..	949	5	.....
Boats ..... miles..	301, 788	2, 492	384

The cost of operating the canal from 1848 to 1885, both inclusive, is given in the following table:

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TABLE 13.—*Exhibit from* 1848 *to* 1885, *inclusive.*

Year.	Ordinary repairs.	Extraordinary repairs, renewals, and hydraulic work.	Gross expenses.	Tolls.	Canal opened.	Canal closed.	Number of days open.
1848	$36,452	$6,744	$43,197	$87,890	Apr. 19	Nov. 29	224
1849	43,922	26,999	70,922	118,375	Apr. 20	Dec. 9	231
1850	38,418	19,996	58,415	125,504	Mar. 22	Dec. 6	259
1851	39,447	19,027	58,475	173,300	Mar. 15	Dec. 8	269
1852	42,816	10,692	33,508	168,577	Mar. 29	Dec. 8	255
1853	40,388	4,486	44,870	173,372	Mar. 14	Dec. 12	274
1854	36,587	16,654	43,242	198,326	Mar. 15	Dec. 2	263
1855	38,216	32,657	70,873	180,519	Apr. 3	Dec. 12	253
1856	33,101	58,357	91,458	184,310	Apr. 8	Dec. 4	241
1857	37,256	65,825	103,082	197,830	May 1	Nov. 20	204
1858	36,115	21,972	58,088	197,171	Apr. 1	Dec. 1	214
1859	34,026	40,406	74,432	132,140	Mar. 16	Dec. 3	264
1860	34,308	48,275	82,583	138,554	Mar. 8	Nov. 26	264
1861	39,238	15,823	55,061	218,040	Mar. 4	Nov. 28	270
1862	40,024	15,337	55,362	264,657	Apr. 1	Dec. 3	247
1863	49,294	13,021	62,715	210,386	Mar. 4	Dec. 1	271
1864	47,535	18,572	66,107	156,607	Mar. 10	Dec. 1	265
1865	39,255	85,614	124,869	300,810	Apr. 10	Nov. 15	218
1866	43,716	72,647	116,363	302,958	Apr. 11	Oct. 31	303
1867	46,152	116,504	162,656	252,231	Apr. 10	Nov. 15	209
1868	52,984	69,067	122,052	215,720	Apr. 4	Oct. 31	210
1869	49,514	42,251	91,765	238,759	Apr. 7	Nov. 15	222
1870	43,098	65,597	108,695	149,635	Apr. 7	Oct. 8	184
1871	54,555	42,667	97,222	159,050	Apr. 6	Nov. 25	234
1872	42,785	46,090	88,876	165,874	Apr. 1	Dec. 1	245
1873	[1]53,525	27,573	81,098	166,641	Apr. 10	Nov. 20	225
1874	[2]49,139	24,659	73,798	144,831	Mar. 30	Nov. 20	236
1875	[3]46,241	28,270	74,511	107,081	Apr. 15	Nov. 28	228
1876	[4]42,418	49,167	91,585	113,203	Mar. 25	Nov. 18	239
1877	[5]54,965	55,053	110,018	96,913	Apr. 16	Dec. 1	230
1878	[6]43,826	39,013	82,839	84,330	Mar. 20	Dec. 1	257
1879	[7]44,076	53,625	97,701	89,064	Mar. 29	Nov. 20	237
1880	[8]47,604	77,997	125,601	92,296	Mar. 22	Nov. 18	242
1881	[9]53,597	54,626	108,223	85,130	Apr. 25	Nov. 26	216
1882	[10]57,309	48,103	105,412	85,947	Mar. 13	Nov. 30	263
1883	[11]56,515	60,241	116,756	77,975	Apr. 2	Nov. 25	238
1884	[12]55,731	43,549	99,280	77,102	Apr. 7	Dec. 1	239
1885	[13]47,659	38,734	86,393	66,800	Apr. 15	Nov. 25	225

NOTE.—The figures in the above table, from 1848 to May 1, 1871, are as given by the trustees of the Illinois and Michigan Canal.

[1] In this amount is $15,400, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $38,125.

[2] In this amount is 15,399, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to maintenance and repairs, $33,740.

[3] In this amount is $14,523, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $31,718.

[4] In this amount is $12,757 paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $29,661.

[5] In this amount is $12,825, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $42.140.

[6] In this amount is $12,954, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $30,872.

[7] In this amount is $14,592, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $29,484.

[8] In this amount is $15,273, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $32,331.

[9] In this amount is $18,299, paid collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $35,298.

[10] In this amount is $18,937, paid to collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $38,732.

[11] In this amount is $21,241, paid to collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $35,274.

[12] In this amount is $22,413, paid to collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $33,318.

[13] In this amount is $16,157, paid to collectors, lock-tenders, and incidentals, which would leave the amount properly chargeable to ordinary repairs, $31,502.

The leases in effect at the close of 1885 are shown in the following table:

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TABLE 14.—*Statement showing leases of water-power, "90-foot strip," lots and lands, and ice on the Illinois and Michigan Canal; also contracts for clay, "spoil-bank," and other stone.*

[NOTE.—In all leases of "90-foot strip" a provision is made for using the ground for enlargement of canal.]

Description of lease.	Date of instrument or last renewal.	Time.	Lessee.	Yearly rental.	Remarks.
LEASES OF WATER-POWER.					
Three runs of stones and lot 1, block 122, Lockport.	July 2, 1873	29 years from Mar. 4, 1873...	Norton & Co	$330.00	Provision for renewal. (Provision made for canceling lease when, in opinion of legislature, the same is not of advantage to State, under act of March 27, 1874.)
Two runs of stones and lot 6, block 122, Lockport.	July 2, 1873	20 years from May 1, 1873...	do	230.00	Do.
Surplus water at Lockport	Sept. 10, 1886	20 years from July 1, 1886...	do	3,300.00	Do.
Water at Dam No. 1, Joliet, and lots connected therewith.	Aug. 10, 1876	20 years from July 17, 1876..	George W. Hyde	1,362.20	Do.
5,834 cubic feet at Dam No. 2, Joliet	Sept. 11, 1883	10 years from July 1, 1883...	John E. Bush	329.14	Do.
12,795 cubic feet at Dam No. 2, Joliet	Sept. 11, 1883	do	Henry A. Sanger	721.98	Do.
6,000 cubic feet at Dam No. 2, Joliet	Jan. 7, 1886	10 years from Jan. 1, 1886....	do	423.18	Do.
5,286 cubic feet on Channahon level below Joliet.	Sept. 11, 1883	10 years from July 1, 1883...	Northwestern Tile Company	551.15	Do.
3,651 cubic feet on Channahon level below Joliet.	Sept. 11, 1883	do	Marsh & Speer	382.30	Do.
2,991 cubic feet on Channahon level below Joliet.	Sept. 11, 1883	do	William M. Druley, S. P., etc	331.96	Do.
Surplus water at Channahon	May 7, 1885	10 years from May 1, 1885...	Oren S. Hurlbert	100.00	Do.
Surplus water at Ottawa	May 1, 1872	20 years from May 1, 1872...	Ottawa Hydraulic Company	750.00	Do.
LEASES OF "90-FOOT STRIP."					
In secs. 30, 39, 14, Bridgeport	Apr. 17, 1884	10 years from October 1, 1882.	Thurber & St. John	50.00	Used for dry-dock.
In secs. 31, 39, 14, Bridgeport	Apr. 17, 1884	10 years from Apr. 17, 1884..	Pouliot & Goulette	50.00	Used for dry-dock.
In secs. 35, 39, 13	Apr. 10, 1883	10 years from Apr. 10, 1883..	Chicago and Alton R. R. Co.	25.00	Used for coaling station.
In secs. 32, 38, 12, Willow Springs	July 10, 1884	5 years from July 1, 1884	John A. McCulloch*	10.00	Used for restaurant stand.
Do	July 10, 1884	do	George W. Beebe*	10.00	Do.
In secs. 30, 37, 11, Lemont	Sept. 18, 1885	5 years from Sept. 18, 1885...	Singer and Talcott Stone Co	25.00	Used for dock, loading stone.
In secs. 25, 37, 10, Lemont	Nov. 16, 1882	10 years from Nov. 9, 1882...	John Reardon	50.00	Do.
In secs. 34, 36, 10, Lockport Township	July 19, 1877	10 years from May 10, 1877..	Sanger & Moody	25.00	Do.
In secs. 3, 35, 10, North Joliet	July 13, 1882	10 years from July 1, 1882...	Joliet Steel Company†	100.00	Used for ore and stone dock.
Do	July 13, 1882	10 years from Aug. 28, 1882..	Houck & Brown	10.00	Used for tannery dock.
In secs. 29, 34, 8, Aux Sable	Jan. 20, 1879	10 years from Jan. 20, 1879...	Richard Hughes	25.00	Leased for stone dock (not used).
In secs. 9, 33, 9, Kankakee feeder	Oct. 24, 1876	10 years from Oct. 24, 1876...	M. Truby & Son	10.00	Leased for warehouse (not used).
In secs. 3, 43, 7, Morris	Aug. 7, 1879	10 years from Aug. 7, 1879...	City of Morris	20.00	Leased by city of Morris to keep off squatters.
Do	Feb. 23, 1881	10 years from Feb. 23, 1881 ..	Allen Paper Car Wheel Co.	100.00	Used for company's business dock.

* These leases contain provision allowing canal commissioners to cancel at any time.
† This lease contains provision allowing either party to terminate on ninety days' notice.

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TABLE 14.—*Statement showing leases of water-power, "90-foot strip," lots and lands, and ice on the Illinois and Michigan Canal, etc.*—Continued.

Description of lease.	Date of instrument on last renewal.	Time.	Lessee.	Yearly rental.	Remarks.
LEASE OF "90-FOOT STRIP"—continued.					
In secs. 9, 33, 7, Morris	Feb. 7, 1879	10 years from Feb. 7, 1879	Charles H. Goold	$5.00	Used for pasture land.
In secs. 23, 24, 33, 5, Seneca	Apr. 16, 1880	10 years from Apr. 16, 1880	Henry Bilhartz	50.00	Used for store building.
In secs. 8, 33, 2, Utica	Aug. 28, 1880	10 years from Aug. 28, 1880	H. S. Gilbert & Co	25.00	Used for warehouse and lumber yard.
Do	June 12, 1884	10 years from June 12, 1884	James Clark	25.00	Used for warehouse and cement dock.
In secs. 9, 33, 2, Utica	....do	10 years from June 1, 1884	.....do	50.00	Used for cement dock.
Do	....do	10 years from July 1, 1884	E. F. Pulsifer	50.00	Used for warehouse and lumber yard.
In secs. 15, 33, 1, La Salle	Aug. 7, 1884	10 years from Aug. 1, 1883	Frederick W. Matthiessen	100.00	Used for warehouse.
LEASES OF LAND AND LOTS.					
S. ½ lot 7, block 35, secs. 21, 39, 14, Chicago	Nov. 23, 1885	10 years from Nov. 23, 1885	Wallace Heckman*	175.00	Buildings for rent on lot.
N. ½ lot 7, block 35, secs. 21, 39, 14, Chicago	....do	.....do	Julia Wilson*	75.00	Do.
Lots 8 and 9, block 12, secs. 29, 39, 14, Bridgeport	Jan. 5, 1882	10 years from Sept. 2, 1882	Philip D. Armour*	5,100.00	Elevator on lots.
Block 13, secs. 29, 39, 14, Bridgeport	Jan. 14, 1886	10 years from Jan. 1, 1886	Joliet Steel Company*	500.00	Ore dock and railroad tract on lot.
Ground at Bridgeport	June 15, 1882	10 years from June 15, 1882	Jefferson Carson*	1,500.00	Lumber yard.
Block A, Bridgeport	Jan. 7, 1886	5 years from Jan. 1, 1886	Mary Sheahan*	100.00	Building on lot.
Strip of ground near mill, Lockport	July 11, 1878	10 years from Mar. 4, 1878	Norton & Co.*	10.00	Mill purposes.
Lots 2, 3, and 5, block 122, and ground near mill, Lockport.	Sept. 13, 1882	10 years from July 1, 1882	.....do	190.00	Paper and flour mill purposes.
Lots 1 and 2, block 2, North Joliet	Jan. 11, 1883	10 years from Jan. 11, 1883	Stanton & Stage	25.00	Ice-house on lots.
Ground in SW. ¼, secs. 17, 34, 9, Channahon	Apr. 17, 1884	10 years from Apr. 11, 1884	Albert T. Randall*	21.00	Used for pasture land.
Lot marked "dry-dock," Morris	Jan. 10, 1884	10 years from Dec. 22, 1883	Ohio Butt Company	100.00	Dock purposes.
ICE LEASES.					
Above Dam No. 1, Joliet	Jan. 7, 1886	5 years from Nov. 17, 1885	Edwin Porter	40.00	Only gives right to cut and remove.
Above Dam No. 1, Joliet, and below guard-lock	Oct. 18, 1884	5 years from Nov. 17, 1884	.....do	56.00	All the ice that may be formed therein.
Pool of dam at Channahon	Dec. 11, 1884	.....do	Jesse L. Watson	10.00	Do.
10,000 feet of canal at Morris	Oct. 18, 1884	.....do	Abraham Loyd	175.00	Do.
2,000 feet of canal at Morris	....do	.....do	Lewis Gebhard	75.00	Do.
2 miles of canal at Seneca	Dec. 11, 1884	.....do	Daniel Shain	50.00	Do.
12,000 feet of canal, feeder, and side cut, at Ottawa.	....do	.....do	Henry Holmes	300.00	Do.
3,000 feet of canal at Ottawa	Oct. 18, 1884	.....do	David Sanderson	126.00	Do.
1,000 feet of canal below Lock 12	Jan. 8, 1885	.....do	County of La Salle	5.00	Do.
1,000 feet of canal at Utica	Dec. 11, 1884	.....do	William P. Dixon	10.00	Do.
4,000 feet of canal above aqueduct, La Salle	....do	.....do	Eliel Brewing Company	50.00	Do.
1,000 feet of steam-boat channel at La Salle	Jan. 8, 1885	.....do	M. & W. Callahan	112.50	Do.

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CLAY CONTRACTS.					
Clay on bank of canal between Kedzie avenue and Belt Railroad crossing.	Mar. 11, 1882	5 years from Mar. 11, 1882...	T. & J. D. T. Tully.....	.....	Monthly payments as taken; aggregate amount not to be less than $750 per year.
Between Western avenue and Grand Trunk crossing.	Jan. 17, 1883	5 years from Jan. 17, 1883 ...	Philip Lichtenstadt.....	.....	Do.
"SPOIL-BANK" STONE.					
Spoil-bank stone on banks of canal between Lockport and Lemont.	Apr. 9, 1880	10 years from Apr. 9, 1880...	James Bruce & Co.....	.....	Monthly payments; at least 2,500 cords per year to be taken.
STONE IN "90-FOOT STRIP."					
All stone in strip opposite their land in sections 20, 37, 11, Lemont.	Oct. 3, 1871	No time given in which to take stone.	Singer & Talcott Stone Company.	.....	$1,000 paid at time contract was made, in full payment; think this stone is nearly all excavated.
All stone in strip opposite their land in sections 20 and 21, 37, 11, Lemont.	Jan. 28, 1873	.....do	Illinois Stone Company.....	.....	$5,049 paid in full at time contract made; stone on one side of canal, at least, nearly taken out.

* Enlargement of canal would not affect the ground.

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The canal lots and canal lands remaining unsold November 30, 1885, with an estimate of their value, are shown in the following table:

TABLE 15.—*Unsold canal lots November* 30, 1885.

Lots.	Block.	Valuation.
Chicago.		
Being in canal commissioner's subdivision of that part of southwest ¼, section 29, township 39, range 14 east, lying south of the main canal, west of Chicago River, and known as blocks 12 and 13 of canal trustees' subdivision of blocks 10, 10½, 11, 12, and 13, southwest ¼, section 29-39-14. Also block A, not previously surveyed or platted in said southwest ¼ section, and east of Chicago River:		
1, 2	12	[1]$50, 000
1, 2	12½	[1]50, 000
	13	12, 000
	A	1, 000
In canal trustees' new subdivision east fraction southeast fractional ¼, section 21-39-14:		
7	35	6, 000
Total		119, 000
Lockport.		
1, 2	71	[2]10, 000
4, 5	102	[3]3, 000
1, 2, 3	103	[3]1, 000
3	114	200
2	116	[4]800
5, 6, 7, 8, 9, 10, 11, 12	121	2, 400
1, 2, 3, 4, 5, 6	122	3, 000
1, 2, 3, 4, 5	123	2, 000
2, 3, 6, 7	124	400
1, 2, 3, 4	125	400
1, 2, 3, 4	126	200
2, 3, 6, 7	127	200
2, 3, 6, 7	128	200
1, 2, 3	129	150
	131	25
	134	50
	135	100
		24, 925
Joliet.		
Northeast ¼ section 9, township 35, range 10 east, 3d P. M., "North Joliet," as laid out by the canal trustees:		
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1	220
1, 2, 3, 4, 5, 6, 7, 8, 9, 10	2	200
4, 5, 6, 7, 8	3	200
10	5	[4]600
11, 12, 13, 14, 15, 16	37	2, 500
Old town of Joliet, east part lot 5, called "McKee tract"	16	3, 000
		6, 720
Du Page (now called Channahon).		
8, 9 (worth nothing; inundated)	4	
3	16	10
1, 2	21	40
Worth nothing; inundated	51	
		50
Kankakee.		
Blocks 30, 31, 32, 33, 34, 37, 38, 39, 40, 41, and 42, being in section 31, township 34, range 9 east, 3d P. M., containing 16.32 acres, at $25 per acre		408
Morris.		
Lying between canal and Illinois River	13	200

[1] Includes buildings, viz: Collector's office, two houses and hydraulic building.
[2] Includes buildings, viz: Canal office, house, and barn.
[3] Includes buildings, viz: Shops at State yard, barn, blacksmith shop, etc.
[4] Includes building, viz: Lock-house.

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TABLE 15.—*Unsold canal lots November* 30, 1885—Continued.

Lots.	Block.	Valuation.
Canal trustees' addition to Morris.		
Block marked on plat as "Dry Dock"		$1,000
		1,200
Ottawa—Original Town.		
	20	10
1, 2, 3, 4, 5, 6, 7, 8	21	4,000
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	22	600
1, 2, 3, 4, 5, 6	23	600
	24	300
	25	500
	26	500
	27	400
	28	50
		6,960
State's addition to Ottawa.		
3, 4, 5	38	[1]3,500
6	43	200
		10,660
La Salle.		
9	41	200
2, 4, 7, 10, 11, 12	45	500
8, 14	101	50
1, 2, 3	141	1,200
1, 2, 3	142	750
		2,700

[1] Including buildings, viz: State shop, barn, sheds, lock-tender's house, etc.

Unsold canal lands November 30, 1885.

Description.	Section.	Town.	Range.	Acres.	Valuation per acre.	Valuation of tract.
Three small islands	15	33	4	.....	.....	$5.00
Part of island in north half	17	33	4	.....	.....	5.00
Island in section	1	33	7	13.09	$1.00	13.09
Strip in	1 and 12	38	12	2.25	1.50	337.50
Total	.....	.....	.....	.....	.....	360.59

RECAPITULATION.

Canal lots.	Valuation.
Chicago, 7	$119,000.00
Lockport, 54	24,925.00
Joliet, 34	6,720.00
Du Page, 6	50.00
Kankakee, 11	408.00
Morris, 2	1,200.00
Ottawa, 36	10,660.00
La Salle, 15	2,700.00
Total	165,663.00
Unsold lands	360.59
Grand total	166,023.59

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The rates of tolls and lockage in force in 1885 are given in the following table:

TABLE No. 16.—*Rates of toll and lockage established upon the Illinois and Michigan Canal and the locks at Henry and Copperas Creek in the Illinois River, by resolution of the Board of Canal Commissioners, passed February 5, 1885, to take effect upon opening of navigation.*

On freight boats, per mile, on the canal, 3 cents.

On freight boats, lockage at Henry and Copperas Creek, per ton measurement at each lock, 1 cent: *Provided*, That no single lockage shall be made for less than $1.50, and also that no steam-boat shall be rated at over 500 tons.

Toll is to be computed upon the weight (1,000 pounds per mile) of all articles contained in the following list, unless otherwise stated.

Lockage at Henry and Copperas Creek to be computed upon the weight (per 1,000 pounds), unless otherwise stated.

Articles.	Tolls.		Lockage.	Articles.	Tolls.		Lockage.
	Through freight.	Local freight.			Through freight.	Local freight.	
	Mills.	*Mills.*	*Cts.*		*Mills.*	*Mills.*	*Cts.*
Beans	2	2	3	Lime, common	1	1	2
Barley	1½	1½	3	Lime, hydraulic	1	1	2
Buckwheat	1½	1½	3	Lead, pipe, sheet, and roll, pigs and bars	1½	2	3
Bran	2	2	3				
Bark, tanners'	1	1	1½	Land plaster, bone-dust, and superphosphate	1	1	1
Barrels, empty	2	2	3				
Cotton, raw, in bales	1	1	3	Merchandise (including hardware, dry goods, cutlery, groceries, crockery, and all other articles not specified)	2	2	3
Corn	1½	1½	3				
Charcoal	1	2	3				
Coal, per ton per mile	7-10	1	1				
Coke	½	½	3	Meal	1½	1½	3
Clay	½	½	3	Machinery	2	2	3
Drainage pipe	1	1	3	Oats	1½	1½	3
Flour	2	2	3	Rye	1½	1½	3
Furniture, household	2	2	3	Salt, in sacks or barrels	1	1½	2
Hay and fodder	2	2	3	Seeds	2	2	3
Hemp	2	2	3	Shorts and screenings	2	2	3
Hoops, and material for	2	2	3	Shipstuff	2	2	3
Hubs, boat-knees, and bolts	2	2	3	Staves and heading	1½	1½	3
Iron, pig, scrap, and railroad	½	½	2	Sand, and other earth	½	½	1
Iron, wrought and cast	2	2	3	Wheat	1½	1½	3
Ice	1½	2	1½	Zinc, spelter	2	2	3
Iron ore	½	½	2				

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TABLE 17.

[On the following articles toll per mile and lockage will be computed by number or measure.]

Articles.		Tolls in mills.		Lockage in cents.
		Through freight.	Local freight.	
On each 1,000 feet of lumber	per mile	4½	5	5
On each 1,000 feet of dressed flooring	do	3	4	5
On each 1,000 feet of siding	do	1½	2	2½
On each 1,000 lath	do	¾	1	1¼
On each 1,000 shingles	do	2–5	½	1
On each 1,000 brick	do	2	3	5
On each 100 split posts (not over 5 inches in diameter) or fence rails, per mile		3	4	5
On each 100 railroad ties	per mile	15	20	8
On each cord of wood for fuel *	do	8	10	8
On each cubic yard (27 cubic feet) dressed or sawed stone †	do	7	10	15
On each cubic yard (27 cubic feet rubble stone †	do	4	5	10
On each cubic yard (27 cubic feet) dimension stone †	do	6	8	15
On each cubic yard (27 cubic feet) macadam stone †	do	2	2	9
Passengers	do			5

"Through freight" is that which is cleared from Copperas Creek or Henry to Chicago, or from Chicago to Henry or Copperas Creek.

"Local freight" includes all other freight.

* Provided that on wood transported over 40 miles the tolls shall not exceed 40 cents per cord. All timber on boats shall be taken board measure.

† Provided that on stone transported over 30 miles the tolls shall not exceed 15 cents per cubic yard on macadam and rubble, and 25 cents per cubic yard on dimension and dressed or sawed stone.

Provided that on clearances from Chicago to Copperas Creek, or from Copperas Creek to Chicago, the lockage on boat and cargo shall be one-half the above rates at each lock, provided the cargo is not transferred before reaching destination as cleared.

Provided that boats passing both locks in the Illinois River shall be charged one-half the above rates of lockage at each lock on boat and cargo.

Boats entering the canal at La Salle, and passing out again without proceeding as far as Ottawa, shall be charged $1 each, if the toll on boat and cargo at above rates should not amount to $1.

The toll on stone shipped from any point on the canal through Henry lock will be figured at through rates.

The weight of a box, rate, vessel, or thing in which any article may be contained shall be added to the weight of the article itself and toll computed accordingly.

Duplicate bills of lading required in all cases, one to be deposited with the collector to whom toll or lockage is paid.

N. B.—The attention of all masters and shippers is herein directed to the following sections of the rules, by-laws, and regulations of the Illinois and Michigan Canal, to wit: Sections 55 to 63, inclusive, and the rules established for the lockage of boats at Henry and Copperas Creek.

TABLE 18.

By resolution dated April 9, 1885, the rate of toll on grain to Chicago was fixed at one mill per 1,000 pounds per mile, and no lockage at Henry or Copperas Creek; and the following rates of toll on lumber, flooring, siding, laths, and shingles from Chicago were adopted for the season of 1885:

Station.	Lumber.	Flooring.	Siding.	Lath.	Shingles.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Lemont	10	8.0	4.0	2.0	1.0
Lockport	12	9.6	4.8	2.4	1.2
Joliet	13	10.4	5.2	2.6	1.3
Bird's Bridge	14	11.2	5.6	2.8	1.4
Channahon	15	12.0	6.0	3.0	1.5
Morris	17	13.6	6.8	3.4	1.7
Seneca	18	14.4	7.2	3.6	1.8
Marseilles	19	15.2	7.6	3.8	1.9
Ottawa	20	15.0	8.0	4.0	2.0
Utica	22	17.6	8.8	4.4	2.2
La Salle	23	18.4	9.2	4.6	2.3
Henry and below	23	18.4	9.2	4.6	2.3

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By resolution of June 15, 1885, the rates to Henry and below were reduced as follows:

	Cents.
Lumber	16.0
Flooring	12.8
Siding	6.4
Lath	3.2
Shingles	1.6

And on grain from Henry and below, $\frac{9}{16}$ of 1 mill per 1,000 pounds per mile, and $1\frac{1}{2}$ cents per 1,000 pounds lockage; from points north of Henry, $\frac{1}{2}$ of 1 mill per 1,000 pounds per mile.

ACQUISITION OF THE CANAL.

The question of the acquisition of the Illinois and Michigan Canal arises from the provisions of the following act of the general assembly of the State of Illinois, approved April 28, 1882, viz:

An Act ceding the Illinois and Michigan Canal to the United States.

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That the Illinois and Michigan Canal, its right of way and all its appurtenances, and all right, title, and interest which the State may now have in any real estate ceded to the State by the United States for canal purposes, be, and are hereby, ceded to the United States for the purpose of making and maintaining an enlarged canal and water-way from Lake Michigan to the Illinois and Mississippi rivers; and this cession is made upon the condition that the United States shall, within five years from the time this act takes effect, accept this grant, and thereafter maintain the said canal and water-way for the purpose aforesaid. In case the United States shall accept this grant, it is upon the express condition that the canal shall be enlarged in such manner as Congress may determine, and be maintained as a national water-way for commercial purposes, to be used by all persons, without discrimination, under such rules and regulations as Congress may prescribe; and the real estate aforesaid, hereby conveyed to the United States, shall be used, and the avails thereof applied, to carry out the object of this grant, and for no other purpose, in such manner as Congress may determine.

SEC. 2. The general assembly shall have power to withdraw and revoke this proposed grant at any time previous to its acceptance by Congress; but when the United States, by act of Congress, shall accept the grant and conditions provided for by section 1 of this act, the governor shall immediately thereafter execute and deliver, in the name of the State of Illinois, to the United States, a deed of cession in accordance with the provisions of this act, and shall then and there, or as soon as practicable, surrender all property mentioned in this act, to be granted to the proper authorities of the United States; and until the delivery of such deed, and acceptance of the same (together with the property conveyed) by the United States, the authority and duty of the State of Illinois to operate said canal, and control its property and appurtenances, shall in no respect be impaired.

SEC. 3. This act shall not take effect until it shall first have been submitted to a vote of the people of the State of Illinois at the general election to be held on Tuesday, the 5th day of November, A. D. 1882, and have been approved by a majority of all the votes polled at such election. At the said election the ballots, in so far as they relate to this act, shall be in the following form: "For the act ceding the Illinois and Michigan Canal to the United States," and when so voted it shall count in favor of this act, but if canceled with ink or pencil it shall be counted against this act. The returns of the whole vote cast at said election, and of the votes for the adoption or rejection of this act, shall be made and canvassed by the same officers and in the same manner as are the returns of the votes for senators and representatives of the State of Illinois; and if it shall appear that a majority of the votes polled are "for the act ceding the Illinois and Michigan Canal to the United States," the governor shall make proclamation thereof, and this act shall take effect from and after the date of such proclamation; but if a majority of the votes cast are "against the act ceding the Illinois and Michigan Canal to the United States," then this act shall be null and void.

Approved, April 28, 1882.

It will be observed that this act of cession is coupled with the condition that the United States shall enlarge and maintain the present canal, but is silent concerning the obligations resting upon the canal,

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and which will continue to attach thereto under whatsoever ownership it may pass.

The Board has made some effort to ascertain what these are, as well as the status of the right of way over certain portions of the line occupied by the canal, but without success, nor did the time within which this report must be submitted permit a full investigation of the matter, even if the requisite expert knowledge were at the disposal of the Board.

It will be further observed that the act is entirely silent concerning the works at Henry and Copperas Creek for the improvement of the navigation of the Illinois River.

It is a grave question whether the present canal should be enlarged and maintained in its entirety, and the Board has arrived at the conclusion that it should not.

In reaching this conclusion it has been governed by the following considerations:

(1) Two locks and dams are under construction by the United States on the Lower Illinois River, above which there is a stretch of 88 miles of river improved and controlled by the State of Illinois (although the United States contributed the sum of $62,359.80 towards the cost).

The act of cession does not include this stretch, and if the canal were accepted by the General Government it would thus possess and be responsible for the two ends of a very important water route, the central portion of which would be under control of another authority.

(2) All dams below La Salle are, or are to be, provided with locks 350 feet long and 75 feet wide, a size unnecessarily large for ordinary canal-boats.

They have been designed with a view to the extension of river steamboat navigation of the first-class between the Mississippi River and Lake Michigan, and form a part of a liberal and wise project, involving the continuation of slackwater navigation from La Salle to Joliet upon the same scale.

It is true the portion of the present canal lying between these points might be enlarged and utilized, but the cost of doing so upon the scale of the improvements below La Salle would be greater than that of improving the river itself, and, even when completed, would not be as easy of navigation. (See Annual Report of Chief of Engineers, 1884, pages 1958, 1959.)

Consequently were the United States in possession of the canal, it would be judicious to abandon it between La Salle and Joliet in favor of the river.

But if the conditions of the act of cession were accepted as they now stand, the United States would be estopped from this course and compelled to enlarge the canal, notwithstanding its greater cost and less efficiency.

(3) The northern terminus of the present canal is in the south branch of the Chicago River, about 5 miles, by its course, from Lake Michigan.

This portion of the river lies in the very heart of the business portion of the city of Chicago, and through it all the commerce to and from the lake must pass.

Numerous bridges span this part of the river, and these are thronged day and night with a vast multitude of passing people and vehicles.

The delays and annoyances arising from the necessity for interrupting all this travel to allow vessels to pass the bridges have become almost intolerable, and will not admit of much greater increase. If, then, there should be such increase in the commerce of the canal as is anticipated

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when its enlargement shall have been effected, it would be practically impossible to take care of it by the present route, without subjecting the people of Chicago to still greater annoyance.

In view of the possibilities of the case, it would appear that whatever enlargement of the canal is made from Joliet northward should not be carried farther than the "Sag," a point whence the line of the canal could be easily diverted to a more favorable terminus.

The Board then presents the following reasons why the United States should not accept the cession of the Illinois and Michigan Canal under the conditions of the existing act: (1) The canal should not be enlarged upon the whole of the present line; on the contrary, it would be judicious to abandon the greater portion of it. (2) The act does not provide for the cession to the United States of that portion of the Illinois River improvement now owned by the State of Illinois, and which forms an essential part of the through line.

3d. The act is not sufficiently definite as to the obligations which the United States would assume in accepting the transfer of the canal.

Although the Board is of opinion that the United States should not accept the canal under the existing conditions, it is further of opinion that the water-route of which the canal forms a part should be controlled by the General Government, and that acceptance should promptly follow a proposition to transfer it under conditions so modified as to remove the objections stated.

In case, however, it should be deemed expedient to ignore the objections presented, and to accept the cession of the canal under the present conditions of the act authorizing the transfer, the following estimate is submitted of the cost of enlarging the canal to the dimensions of the proposed Hennepin Canal, that is to say, for a prism 80 feet wide at surface, 59 feet wide at bottom, and 7 feet deep, with locks 170 feet long, 30 feet wide, and 7 feet of water on the miter-sills:

Length, miles	97.24
Number of locks	16
Estimated cost of construction	$2,298,919.15
Estimated annual cost of maintenance and ordinary repairs	50,000.00

It is impracticable to estimate for extraordinary repairs, renewals, etc. These will have to be provided for from time to time by the necessary appropriations for that purpose.

(See Annual Report Chief of Engineers, 1883, pages 1788 and 1789.)

Respectfully submitted.

C. B. COMSTOCK,
Lieut. Col. of Engineers, and Bvt. Brig. Genl.
O. M. POE,
Lieut. Col. of Engineers, and Bvt. Brig. Gen., U. S. A.
JAS. C. POST,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

List of appendices accompanying this report.

No. 1.—Acts of Congress relating to Illinois and Michigan Canal of March 30, 1822, and March 2, 1827.
No. 2.—Navigable depths on Upper Mississippi, from Maj. A. Mackenzie.
No. 3.—Acts of State of Illinois in reference to Illinois and Michigan Canal.
No. *4.—Freight rates in the vicinity of Saint Paul, furnished by the kindness of Maj. C. J. Allen, but received too late for use in the report.

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No. *5.—Letters from F. Barker and E. M. Dickey in reference to freight rates on the Upper Mississippi.
No. *6.—Papers from O. Guthrie in reference to the Illinois and Michigan Canal.
No. *7.—Letter from J. C. Dove in reference to the Hennepin Canal.
No. *8.—Paper by Governor William Bross in reference to the Hennepin Canal.
No. *9.—Papers from the Enterprise Club in reference to the Hennepin Canal.
No. 10.—Papers from Governor R. J. Oglesby.
No. *11.—Papers from Citizens' Committee of Rock Island and Davenport in reference to the Hennepin Canal.
No. 12.—Map of route of Illinois and Michigan and Hennepin canals.

APPENDIX No. 1.

CHAP. LI.—AN ACT to grant a quantity of land to the State of Illinois for the purpose of aiding in opening a canal to connect the waters of the Illinois River with those of Lake Michigan.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be, and hereby is, granted to the State of Illinois, for the purpose of aiding the said State in opening a canal to unite the waters of the Illinois River with those of Lake Michigan, a quantity of land equal to one-half of five sections in width, on each side of said canal, and reserving each alternate section to the United States, to be selected by the Commissioner of the Land Office, under the direction of the President of the United States, from one end of the said canal to the other; and the said lands shall be subject to the disposal of the legislature of the said State for the purpose aforesaid, and no other: *Provided*, That the said canal, when completed, shall be and forever remain a public highway for the use of the Government of the United States, free from any toll or other charge whatever for any property of the United States, or persons in their service, passing through the same: *Provided*, That said canal shall be commenced within five years, and completed in twenty years, or the State shall be bound to pay to the United States the amount of any lands previously sold, and that the title to purchasers under the State shall be valid.

SEC. 2. *And be it further enacted*, That, so soon as the route of the said canal shall be located and agreed on by the said State, it shall be the duty of the governor thereof, or such other person or persons as may have been, or shall hereafter be, authorized to superintend the construction of said canal, to examine and ascertain the particular sections to which the said State will be entitled under the provisions of this act, and report the same to the Secretary of the Treasury of the United States.

SEC. 3. *And be it further enacted*, That the said State, under the authority of the legislature thereof, after the selection shall have been so made, shall have power to sell and convey the whole, or any part of the said land, and to give a title in fee-simple therefor, to whomsoever shall purchase the whole or any part thereof.

Approved, March 2, 1827. (4 U. S. Stat., 234.)

CHAP. XIV.—AN ACT to authorize the State of Illinois to open a canal through the public lands, to connect the Illinois River with Lake Michigan.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the State of Illinois be, and is hereby, authorized to survey and mark, through the public lands of the United States, the route of the canal connecting the Illinois River with the southern bend of Lake Michigan; and ninety feet of land on each side of said canal shall be forever reserved from any sale to be made by the United States, except in the cases hereinafter provided for, and the use thereof forever shall be, and the same is hereby, vested in the said State for a canal, and for no other purpose whatever; on condition, however, that if the said State does not survey and direct by law said canal to be opened, and return a complete map thereof to the Treasury Department within three years from and after the passage of this act; or if the said canal be not completed, suitable for navigation, within twelve years thereafter; or if said ground shall ever cease to be occupied by, and used for, a canal, suitable for navigation; the reservation and grant hereby made shall be void and of none effect: *Provided always, and it is hereby enacted and declared*, That nothing in this act contained, or that shall be done in pursuance thereof, shall be deemed or construed to imply any obligation on the part of the United States to appropriate any money to defray the expenses of surveying or opening said canal: *Provided also, and it is hereby further enacted and declared*, That the said canal, when completed, shall be, and forever remain, a public highway for the use of the Government of the United States, free from any toll or other charge whatever, for any property of the United States, or persons in their service, passing through the same.

*Omitted. Printed in House Ex. Doc. No. 79, Forty-ninth Congress, second session.

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SEC. 2. *And be it further enacted*, That every section of land through which said canal route may pass shall be, and the same is hereby, reserved from future sale until hereafter specially directed by law; and the said State is hereby authorized and permitted, without waste, to use any materials on the public lands adjacent to said canal that may be necessary for its construction.

Approved, March 30, 1822. (3 U. S. Stat., 659.)

APPENDIX No. 2.

LETTER FROM MAJOR A. MACKENZIE, CORPS OF ENGINEERS, WITH TABLES SHOWING NAVIGABLE DEPTHS ON UPPER MISSISSIPPI RIVER.

UPPER MISSISSIPPI RIVER IMPROVEMENT,
UNITED STATES SNAG-BOAT GENERAL BARNARD,
Lansing, Iowa, September 17, 1886.

DEAR GENERAL: The inclosed table for 229 days of each year, from 1879 to 1885, is made up from the gauge-readings at the points mentioned, it being assumed at each point that at zero of the gauge there would be 2 feet of water. The results are not satisfactory, for since the river has been improved there are always 3 feet from Rock Island to Saint Paul, and nearly always 3½. It is quite impossible to estimate how many days you can carry 2, 3, 4, 5, and 6 feet from La Crosse to Saint Paul and from Rock Island to La Crosse, but assuming (which is correct) that there are always 3 feet, we may use the La Crosse figures for 1885 for the river from La Crosse to Saint Paul for 4, 5, and 6 feet, and the Rock Island figures for the river from Rock Island to La Crosse.

It often happens, and may occur at any point, that the river is very shallow during a changing of channel for a week or more, and it is very difficult to keep track of cases of this kind.

Very truly,

A. MACKENZIE,
By C. W. DURHAM,
Assistant Engineer.

General C. B. COMSTOCK,
United States Engineer.

Table showing the number of days between April 1 *and November* 15 *there have been* 6 *feet,* 5 *feet,* 4 *feet,* 3 *feet, and* 2 *feet of water in river at Saint Paul, La Crosse, Dubuque, and Rock Island.*

[Two feet is taken as the depth at low water of 1864. Total number of days, 229.]

Year.	Saint Paul.					La Crosse.				
	Two feet.	Three feet.	Four feet.	Five feet.	Six feet.	Two feet.	Three feet.	Four feet.	Five feet.	Six feet.
1879	229	229	110	80	68	229	223	129	89	86
1880	229	229	151	122	112	229	229	151	124	115
1881	229	229	223	219	200	229	229	227	170	164
1882	229	229	229	222	164	229	229	223	203	161
1883	229	229	134	115	107	229	229	163	132	124
1884	329	229	205	172	127	229	229	109	170	161
1885	229	229	229	195	102	229	229	228	229	189
Average	229	229	183	161	126	229	228	189	160	143
	Dubuque.					Rock Island.				
1879	229	229	192	115	78	229	229	171	94	63
1880	229	229	229	197	132	229	229	229	167	133
1881	229	229	229	227	203	229	229	229	214	190
1882	.....	.....	.....	.....	.....	229	229	229	195	168
1883	229	229	229	204	147	229	229	239	189	139
1884	229	229	229	211	176	229	229	229	197	167
1885	229	229	229	204	179	229	229	229	213	189
Average	229	229	223	193	163	229	229	221	181	150

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APPENDIX No. 3.

AN ACT to provide for the completion of the Illinois and Michigan Canal, in force April 16, upon the plan adopted by the State in 1836.

Whereas it has been represented that the city of Chicago, in order to purify or cleanse Chicago River by drawing a sufficient quantity of water from Lake Michigan directly through it, and through the summit division of the Illinois and Michigan Canal, would advance a sufficient amount of funds to accomplish this desirable object; and

Whereas the original plan of the said canal was to cut down the summit so as to draw a supply of water for navigation directly from Lake Michigan, which plan was abandoned for the time being, after a large part of the work had been executed, only in consequence of the inability of the State to procure funds for its further prosecution; and

Whereas under the law creating the trust the plan of the summit division of the canal was changed, the level being raised so as to require the principal supply of water to be obtained through the Calumet feeder, subject to serious contingencies, and by pumping on to the summit with the hydraulic works at Bridgeport: Now, therefore,

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That to secure the completion of the summit division of the Illinois and Michigan Canal, upon the original "deep cut" plan, with such modifications and changes of line, if necessary, as will most effectually secure the thorough cleansing or purification of the Chicago River and facilitate the execution of the work, the city of Chicago, through its constituted authorities, may at once enter into an arrangement with the board of trustees of said canal, with a view to the speedy accomplishment of the work.

2. The canal shall not be constructed of a less capacity than the plan adopted by the canal commissioners in 1836, nor shall the work of deepening it be prosecuted so as to materially interfere with the navigation. By consent of the board of trustees, however, the navigation may be opened later and closed earlier than usual in former years, but it shall never be diminished to a less time than six months.

3. It shall be lawful for the city of Chicago to enter upon and use any lands which may be necessary for the right of way for said canal, if the route should in any part vary from the present line of canal, and to take and use any materials, of any description, necessary for the prosecution of the work contemplated along the line thereof; the value of the same to be determined in the mode provided by the general laws of this State.

4. The amount expended by the city of Chicago in deepening the summit division of the canal, according to the plan adopted by the canal commissioners in 1836, shall be a vested lien upon the Illinois and Michigan Canal and its revenues, after the payment of the present canal debt, and the net revenues of the canal shall all thereafter be applied to the payment of the principal and interest of the same expended in accomplishing the object of this act until the whole amount is reimbursed to the city: *Provided*, The cost shall not exceed two and a half millions of dollars.

5. The State of Illinois may at any time relieve this lien upon the canal revenues by refunding to the city of Chicago the amount expended in making the contemplated improvement and the interest thereon.

Approved, February 16, 1865.

UNITED STATES OF AMERICA,
State of Illinois, ss:

OFFICE OF SECRETARY.

I, Henry D. Dement, secretary of state of the State of Illinois, do hereby certify that the foregoing is a true copy of an act to provide for the completion of the Illinois and Michigan Canal, upon the plan adopted by the State in 1836, approved February 16, 1865, the original of which is now on file in this office.

In witness whereof I hereto set my hand and affix the great seal of State, at the city of Springfield, this 5th day of November, A. D. 1886.

[SEAL] HENRY D. DEMENT,
Secretary of State.

AN ACT to relieve the lien of the city of Chicago upon the Illinois and Michigan Canal and revenues by refunding to said city the amount expended by it in making the improvement contemplated by "An act to provide for the completion of the Illinois and Michigan Canal upon the plan adopted by the State in 1836," approved February 16, 1865, together with the interest thereon, as authorized by section 5 of said act, and to provide for issuing bonds therefor.

Whereas the city of Chicago has expended a large amount of money, to wit, the sum of two and a half millions of dollars, to secure the completion of the summit division of the Illinois and Michigan Canal, under and pursuant to the provisions of

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said acts, so approved February 16, A. D. 1865, and acts supplementary thereto; and whereas the said city has a vested lien upon the said canal, with its revenues, subject to any canal debt existing at the time of the passage of said acts; and whereas said then existing debt due by the State has been fully paid and canceled; and whereas the canal trustees have delivered to the State of Illinois possession and control of said canal; and whereas it is provided by section 5 of said act as follows: "The State of Illinois may at any time relieve this lien upon the canal and revenues by refunding to the city of Chicago the amount expended in making the contemplated improvement and the interest thereon": Now, therefore,

SECTION 1. *Be it enacted by the people of the State of Illinois, represented in the general assembly*, That the sum of two million nine hundred and fifty-five thousand three hundred and forty dollars, with interest thereon until paid, be, and the same is hereby, appropriated for the purpose of relieving the lien as aforesaid, being the principal expended and the interest thereon, which said sum is hereby refunded to said city, and when paid said city shall execute and deliver to the State of Illinois a proper release of said lien to the satisfaction of the governor; and th auditor of State, under the direction of the governor, is hereby directed to draw his warrant for said sum of money and interest, payable only out of any moneys in the treasury belonging to the fund hereafter provided, to be known as the "canal redemption fund." That for the purpose of providing said fund, any funds that are now or may be hereafter in the State treasury, paid in on the settlement of the canal commissioners with the trustees of the Illinois and Michigan Canal, as well as from the revenues of the canal; also all funds that are now or may hereafter be paid into the State treasury known as the Illinois Central Railroad fund, shall be transferred by the State treasurer, upon the auditor's warrant drawn for that purpose, to said redemption fund; that a tax of one and one-half mills on each dollar of the assessed value of all the taxable property of the State be levied as a special tax for the years 1871 and 1872; and to meet any deficit in said revenues to meet said appropriation the governor, auditor, and treasurer are hereby authorized to issue bonds of the State of Illinois to the amount of two hundred and fifty thousand dollars, said bonds to bear interest at the rate of 6 per cent. per annum, payable semi-annually in the city of New York, and shall be paid at pleasure of the State at any time after three years after the date thereof, and shall be of such denomination as the governor may deem advisable, and be known as the "revenue deficit bonds," and shall be delivered to the city authorities of the city of Chicago, at par, as a part payment on above appropriation: *Provided, however*, That not less than one-fifth, nor to exceed one-third, of said sum so appropriated shall be received by said city, and be applied in reconstructing the bridges and the public buildings and structures destroyed by fire upon the original sites thereof, as already provided by the common council, and the remainder thereof to be applied to the payment of the interest on the bonded debt of such city, and the maintenance of the fire and police department thereof.

Whereas by reason of a great conflagration in the city of Chicago the public buildings, bridges, and other public improvements have been totally destroyed and the business of the courts is suspended, whereby an emergency exists as a reason why this act shall take effect before the first day of July next: Therefore,

Be it further enacted, That this act shall take effect and be in force from and after its passage.

Approved October 20, 1871.

UNITED STATES OF AMERICA,
State of Illinois, ss:

OFFICE OF SECRETARY.

I, Henry D. Dement, secretary of state of the State of Illinois, do hereby certify that the foregoing is a true copy of an act to relieve the lien of the city of Chicago upon the Illinois and Michigan Canal and revenues, by refunding to said city the amount expended by it in making the improvement contemplated by "An act to provide for the completion of the Illinois and Michigan Canal upon the plan adopted by the State in 1836," approved February 16, 1865, together with the interest thereon, as authorized by section 5 of said act, and to provide for issuing bonds therefor, approved October 20, 1871.

The original is now on file in this office.

In witness whereof I hereto set my hand and affix the great seal of State, at the city of Springfield, this 5th day of November, A. D. 1886.

[SEAL.]

HENRY D. DEMENT,
Secretary of State.

ILLINOIS AND MICHIGAN CANAL—FEEDERS.

Whereas the State of Illinois in general assembly, did, on the 16th day of February, 1865, grant and authorize the city of Chicago, in the State of Illinois, to deepen the Illinois and Michigan Canal for the purpose of and with the intent to better the

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system of sewerage of the said city of Chicago, by permitting a free flow of water from Lake Michigan through the Chicago River and said canal to the Des Plaines and Illinois rivers, and the city of Chicago did perfect said improvement in conformity with said permission; and

Whereas the great fire in the said city of Chicago on the 8th and 9th days of October, A. D 1871, did so greatly damage the assessable property of a very large number of its citizens and tax-payers, and the people of the State of Illinois did by its general assembly refund to the said city of Chicago the amount of the cost of deepening the Illinois and Michigan Canal, said sum refunded being in gross $2,955,340; and

Whereas the deepening of the canal, as aforesaid, has proved to be totally inadequate for the purposes intended, and the large amount of sewage of the city of Chicago being far greater than the capacity of the canal and the water now passing through it to deodorize and render innocuous; and

Whereas the foulness of the water annually causes the death of millions of fish in the Des Plaines and Illinois rivers, that float to the shores and decay; and

Whereas said sewage, in an entirely undecomposed and putrid mass, is carried by the current of the canal into the Des Plaines River, and thence into the Illinois River, and in its foulest conditions is thus transported to and below the city of Peoria, in said State, rendering the air at all points along its passage so impure and foul as to be exceedingly offensive, and taking with it germs of disease of all kinds prevalent in the city of Chicago, and thus spreading them broadcast through the entire Des Plaines and Illinois river valleys, causing thereby much illness as well as poisoning of the blood and debilitating the systems of 200,000 people; and

Whereas careful investigation leads our people to fear that an epidemic may spread over said section of the State of Illinois from the causes above stated; and

Whereas, in addition to the above distress, there has been a great loss to property, business industries, and to the communities in said region by reason of the causes herein mentioned; and

Whereas prior to the deepening of said Illinois and Michigan Canal the water necessary for all purposes of navigating said canal, and propelling of machinery was obtained from the Des Plaines River and the Calumet feeder, through Lane's Lake; and

Whereas the bed of the Des Plaines River at the summit, and thence westward along the line of, and adjacent to, the canal, is at a low stage of water 8 feet above the surface level of the canal, and will average a supply of water sufficient for all canal purposes during the season of navigation; and

Whereas the supplying of the canal from these sources will so dilute and weaken the sewage of the city of Chicago as to greatly relieve it of its foulness and stench, to the great delight, relief, and health of the people near to and bordering upon the line of the canal, the Des Plaines and Illinois rivers: Therefore, be it

Resolved by the senate (the house of representatives concurring herein), That the board of canal commissioners of the Illinois and Michigan Canal be, and they are hereby, directed to cause sluice-ways of sufficient capacity, with the proper guard-gates, to be opened from the Des Plaines River to the canal at or near the summit, in Cook County, and at or near Lemont, in Cook County, and also to construct a dam across the former Calumet feeder at such suitable point as will cause the waters from Lane's Lake to flow into the canal; that said canal commissioners shall immediately commence, construct, and improve said sluices and feeders in the order named, and pay for the same out of any moneys in their hands or control as canal commissioners resulting from the earnings of the canal. The amount to be expended as above designated in the prosecution of said improvement shall not, however, exceed the sum of ten thousand dollars: *Provided*, That the canal commissioners shall first confer with the mayor and other proper authorities of the city of Chicago, and if said city shall proceed without delay to cause a flow into the canal from the Chicago River sufficient to dilute and purify the waters, and thus remedy the evils complained of, said flow to be not less than 60,000 cubic feet per minute, including the ordinary flow into the canal from the Chicago River, or so much thereof as in their judgment the said canal can carry; and if this shall be accomplished by the 1st day of September, 1881, the commissioners shall accept it in lieu of obtaining a supply of water from the other sources named: *Provided, further*, That said commissioners are hereby directed to take care of the 60,000 cubic feet per minute, above contemplated, if so furnished by the city of Chicago: *Provided, further*, That the adoption of this resolution shall not commit the State to a system of permanent drainage of Chicago sewerage through either the canal or Des Plaines or Illinois rivers, but that the State reserves the right to require the city of Chicago, in future years, to take care of its sewage through other channels: *And provided, further*, That the said city of Chicago shall erect pumping works for the purpose of causing such flow, as aforesaid, the canal commissioners shall allow the said city to erect said pumping works upon the canal lands in Bridgeport, and said city shall support, control, and manage said pumping works, subject to the directions of the canal commissioners, relative to the amount of

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water to be received into the canal from time to time, as the exigencies of the canal may require, but at the expense of said city of Chicago: *Provided, further*, That the city of Chicago, its officers, agents, or employés shall derive from this resolution no right to control or exercise any authority over any of the gates, locks, or dams of said canal.

APPENDIX No. 10.

LETTER FROM HON. R. J. OGLESBY, GOVERNOR OF ILLINIOS.

STATE OF ILLINOIS, EXECUTIVE OFFICE,
Springfield, October 18, 1886.

DEAR SIR: Upon the receipt of your letter of the 28th of September last, it was referred to the Board of Canal Commissioners of the State of Illinois, with directions to furnish, in authentic shape, the information desired in said communication.

Your communication of the 5th instant, in which you state "I would ask to be informed what rights or privileges have been granted to Chicago by the State of Illinois in this matter, or have been acquired without grant; and to be furnished with copies of any such grant, authority, or other action by the State, or by any of its officers," was, in like manner, referred to the Board of Canal Commissioners.

I have the honor to inclose herewith a "statement showing leases of water-power, 90-foot strip, lots and lands, and ice on the Illinois and Michigan Canal; also contracts for clay, spoil-bank, and other stone," transmitted by our canal commissioners, which I trust will enable your board to arrive at a correct and exact understanding of the matters covered by said statement in so far as the same is responsive to the four points mentioned in your first communication.

I also inclose you a printed list* of locks and lands still belonging to the canal referred to in the communication of the canal commissioners to me of date October 7, 1886; and also please find a copy of a communication from George F. BROWN, secretary of the Board of Canal Commissioners, addressed to me of date October 7, 1886.

In response to the inquiries contained in your communication of the 5th instant, I inclose you herewith a type-writer copy of an act of the general assembly of the State of Illinois, approved February 16, 1865, which conferred upon the city of Chicago the power to enter upon the summit division of the Illinois and Michigan Canal, and to complete the same according to the original deep-cut plan, with modifications, etc., as stated in said act; and an act of the general assembly of the State of Illinois, approved October 20, 1871, entitled "An act to relieve the lien of the city of Chicago upon the Illinois and Michigan Canal and revenues," etc., by which last-mentioned act you will observe the State of Illinois made provision for refunding to the city of Chicago $2,955,340, to relieve the State of the lien created upon said canal for any amount expended by the city of Chicago in the improvement of the same.

The original copy of an act approved 16th of February, 1865, will be found on pages 83 and 84 of the session laws of 1865; and the original act approved October 20, 1871, will be found on pages 170, 171, and 172, of the session laws of 1871 and 1872 of the State of Illinois.

To the total sum expended by canal commissioners and canal trustees, $6,557,681.50, the cost of constructing the Illinois and Michigan Canal, may be added the sum of $2,955,340, the amount paid by the State to the city of Chicago, as provided in the act of October 20, 1871, being the amount expended by the State of Illinois in the construction and completion of said canal.

Very respectfully, yours,

R. J. OGLESBY.

Gen. C. B. COMSTOCK,
President Board of Canal Engineers.

LETTER FROM THE BOARD OF CANAL COMMISSIONERS OF ILLINOIS.

STATE OF ILLINOIS,
BOARD OF CANAL COMMISSIONERS,
General Office, Lockport, Ill., October 7, 1865.

SIR: The letter of your private secretary of 2d instant, inclosing one from Col. C. B. Comstock, one of the Board of Engineers appointed by Congress to examine the canal, is duly received.

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*Omitted here. It may be found printed in Report of Board of Engineers as Table No. 15.

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In reply thereto we would submit the following:

(1) The cost of constructing the Illinois and Michigan Canal was—

Amount expended by the canal commissioners	$5,133,062.21
Amount expended by the canal trustees	1,424,619.29
Total	6,557,681.50

This does not include the amount expended by the city of Chicago in deepening the summit level of the canal, and refunded to said city after the fire in 1871 by act of the legislature of this State, approved October 20, 1871.

(2) There was granted to the State of Illinois by act of Congress approved March 2, 1827, the alternate sections of land for 5 miles on either side of said canal. The odd-numbered sections were selected under the grant, and through those sections the bed of the canal and 90 feet on either side have always been reserved from sale.

In Lockport and Ottawa the canal is of double width (120 feet), and the canal officials laid out and sold lots right up to the bank on one side of the canal; on the other, in Lockport, a street is laid outside of the tow-path, and in Ottawa the "ninety feet" is reserved.

A list of the lots and land still belonging to the canal may be found in the appendix to the last report of the canal commissioners, pages 27 and 28, which is herewith inclosed.

(3) Through the even-numbered sections right of way was granted, and 90 feet on either side, by act of Congress of March 30, 1822. In some instances land through which the canal passes was patented before this grant, and through such sections no "90-feet strip" is claimed.

(4) A list is herewith inclosed, showing the leases of water-power, "90-feet strip," lots and lands, and ice, also the contracts for clay and stone now existing.

Respectfully submitted.

GEO. F. BROWN,
Secretary Commissioners.

Hon. R. J. OGLESBY,
Governor, Springfield, Ill.

II 4.

IMPROVEMENT OF THE CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this improvement so far as at present projected is to secure a channel 200 feet wide and 16 feet deep, from Calumet Harbor, Illinois, to one-half mile east of Hammond, Ind., with the view to increasing the facilities for handling the growing commerce of this region, and also to aid in providing means for the better accommodation of much of the commerce that must be reshipped somewhere in the vicinity of Chicago and which is now very much crowded in that city.

The river and harbor act of July 5, 1884, appropriated $50,000 for the improvement of that section of the river from the harbor to the outlet from Lake Calumet, with the following proviso:

That no part of said sum shall be expended until the right of way shall have been conveyed to the United States free from expense, and the United States shall be fully released from all liability for damages to adjacent property owners, to the satisfaction of the Secretary of War.

Parties directly interested in the improvement of this section of the river have for some time been actively engaged in securing to the United States the right of way and releases required by the above proviso. The matter is now so far advanced as to be placed in the hands of the United States district attorney for the northern district of Illinois for examination of titles and preparation of the necessary legal papers.

Work will be commenced on this section of the river as soon as the requirements of the proviso have been complied with.

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The river and harbor act approved August 5, 1886, appropriated an additional sum of $30,000 for the improvement of this river, a part of which was designated by Congress to be used in dredging in the river between the Forks and one-half mile east of Hammond. This part was further divided at the State line between Illinois and Indiana.

The status of this appropriation and the work dependent thereon will be understood from the following extract from my letter of May 28, 1887, submitting a project for the expenditure of the available portion of it:

The language of that part of the act which relates to this appropriation reads as follows:

"Improving Calumet River, Illinois: Continuing improvement, thirty thousand dollars; of which eleven thousand two hundred and fifty dollars are to be used between the Forks and one-half mile east of Hammond, Indiana, five thousand six hundred and twenty-five dollars of which are to be used in dredging the river between the Forks and the State line of Illinois and Indiana, and five thousand six hundred and twenty-five dollars on the river at Hammond, Indiana: *Provided, however*, That no part of said sum, nor any sum heretofore appropriated, except the said eleven thousand two hundred and fifty dollars, for the river above the Forks, shall be expended until the entire right of way, as set forth in Senate Executive Document number nine, second session, Forty-seventh Congress, shall have been conveyed to the United States free of expense, and the United States shall be fully released from all liability for damages to adjacent property owners, to the satisfaction of the Secretary of War; and if any of the owners of real estate required to be taken, or that is damaged for the purpose of straightening or widening that portion of the Calumet River for which the appropriation herein is now made, can not be induced to convey to the United States such real estate so required, and release their claim for damages caused by said improvement, or should the owner or owners be incapable of conveying and releasing, or should his or her name or residence be unknown, or he or she be a non-resident of the State of Illinois, it shall then be the duty of the United States attorney for the northern district of Illinois to immediately file a petition in any court having jurisdiction thereof, in the manner and as authorized by the laws of the State of Illinois in such cases, for the purpose of ascertaining the just compensation to be paid to the respective owners of the land taken or damaged: *Provided, however*, That the other owners of property and parties interested in said improvement shall first execute a bond to the United States, to be approved by the Secretary of War, for the payment of the costs of such proceedings, and to pay any judgment that may be rendered therein, and on failure to do so the proceedings shall be dismissed."

In your letter of February 10, 1887, referring to previous instructions upon this matter, I am cautioned to take great care in preparing my project, that no work be proposed which will be calculated to render the United States liable for damages caused by infringements upon private rights.

In order to ascertain to what extent the projected improvement for the Calumet River between the Forks and one-half mile east of Hammond, that was before Congress when this appropriation was made, and which it is assumed is to be carried out so far as the amount will suffice, would infringe upon private rights, and also whether the amount allotted could be expended in carrying out the project without rendering the United States liable for damages caused by infringements, in case the right of way was not previously obtained, it was necessary to collect additional data and go into a more thorough investigation of the subject than could be undertaken with the means at hand at the time the project was originally submitted to Congress.

For reasons given in my letter of December 4, 1886, I was authorized by Department letter of December 23, 1886, to make additional surveys of the Calumet River between the Forks and one-half mile east of Hammond, Ind. These additional surveys consisted in locating accurately the recognized section lines and corners in the vicinity of the river, and from them plotting the various parcels of ground as they are shown upon the title plats in the county recorder's office. Copies of the original plats of the meander lines of the stream were obtained from the General Land Office, and copies of the original notes of these meanders were obtained from the recorder's office of Cook County, Ill., and Lake County, Ind. All these additional data have been plotted upon the map of this reach of the river made in this office in 1886, a tracing from which accompanied my project for improving Calumet River from the Forks to one-half mile east of Hammond, submitted January 6, 1886. A tracing from this map as it now stands, with these additions and changes, is herewith submitted, in a separate roll, to form part of this report.

It was thought that by plotting the original meander lines of the stream upon the map it would appear that the boundaries of the projected channel-way could be

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changed, without detriment to the character of the improvement, so that in general they would be found within the meander lines, thus avoiding to a considerable extent infringing upon private rights and the necessity for obtaining right of way and release from liability for damages; but when these came to be used the line ran so wild over the territory that no reliance could be placed upon the accuracy of the notes. Where the meanders cross the section lines they appear to be reasonably accurate; between these points no reliance can be placed on them. The results are shown upon the tracing by the broken sepia lines. Within the limits of the State of Indiana the meander lines appear wide apart, giving ample room for the projected channel. In Illinois they are near together; in general less than 200 feet apart.

The shore line of the Calumet River is poorly defined. The banks are very low, and throughout nearly the whole of the reach now under consideration the wet season finds the country generally a swamp. Here and there are small patches of the bank that rise above the general level.

These, with the ground that is artificially raised, are generally occupied by large manufacturing establishments. The ordinary level of the water in the river does not differ materially from that in Lake Michigan. The channel soundings shown upon the map are referred to the same plane used for the soundings in Calumet Harbor, which plane is 1 foot above Chicago City datum. The present navigable channel through this region is very narrow, and not capable of being improved to any great extent without being widened and deepened throughout. Under these circumstances, and with the abutting property owners claiming to the thread of the stream, and no line to determine where navigable rights should begin, it is difficult to determine how far the United States can enter upon the improvement contemplated by Congress without becoming liable for damages for infringement upon private rights.

The limits within which there can be no doubt upon this point are very circumscribed.

So far as I have been able to ascertain from conversation with parties owning or controlling property affected by the contemplated improvement, it seems to be universally conceded that the work should be carried forward on the basis of a channel 200 feet wide and 16 feet deep; and these property owners seem ready and willing to concede to the United States every necessary right of way and release from liability to damages.

From the fact that the Attorney-General has given the district attorney for the northern district of Illinois instructions to procure these releases, as shown by the copy of his letter to the Secretary of War, dated February 19, 1887, sent to me with your letter February 25, 1887, I infer that he is of opinion that releases are necessary for this part of the river as well as for the part to which the balance of the amount appropriated is applicable.

Since the project for this improvement was submitted to Congress, parties controlling property along the river have of their own accord, in one instance, projected a channel-way differing considerably from the one proposed. This occurs on the bend, at the town marked Burnham upon the map. This change is very much to the benefit of navigation, and it was made by the parties with the full expectation that they would be required to give to the United States the right of way through the property and release from all liability for damages before the work of improvement was commenced. On the basis of their projected channel-lines, the Pennsylvania Company has built a railroad bridge over the river at this point. The change in the channel lines will increase the cost of the river improvement slightly and improve navigation very considerably. This change is shown upon the map.

It would seem from this exhibit of the state of affairs at present existing in this locality that it would be for the best interests of all concerned, and especially those of the Government, to await the action of the Attorney-General's Department on the matter of the releases and right of way before commencing the actual work of dredging the channel. If the language of the act making the appropriation be not considered compulsory in regard to the immediate expenditure of the amount allotted for this work, it is suggested that in the light of the new data now laid before the Chief of Engineers he may deem this course of procedure the proper one.

Your attention has been called by the Hon. W. D. Owen, M. C., to a view of this language, from which it appears that it was the design of Congress that the $11,250 allotted from the appropriation of $30,000 for continuing the improvement of the Calumet River, Illinois, to the river between the Forks and one-half mile east of Hammond, Ind., should be expended in dredging, without awaiting the grant of the right of way and release from liability to damages from the adjacent property owners.

There does not seem to be any evidence that the work to be done with this sum is not to be considered by Congress as a part of the approved project for the improvement of the river.

The United States can certainly proceed without let or hinderance to the improvement of what is now the recognized channel of the river, provided that in doing so

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there be no encroachments upon or damage to property adjacent thereto. This channel I conceive to be shown by the soundings upon the accompanying map.

There are some points on the reach of the river between the Forks and the State line between Illinois and Indiana where dredging can be done in this channel to the benefit of the present navigation of the river. On account of shoal water in the reach below the Forks, vessels drawing more than 7 feet can not get into the reach above. It would, therefore, be useless, as far as present navigation is concerned, to dredge to a greater depth than 7 feet.

Within the State of Indiana and in the town of Hammond it would be a great convenience for the shipping if a basin could be provided, even of 7 feet depth, where the vessels that at present frequent the place could be turned. At present they are obliged to go a considerable distance from the dock before this can be accomplished.

This basin could be made within the proposed 200 feet channel lines, and in my judgment without rendering the United States liable for any damages whatever.

To comply with the instructions contained in your letters of February 9 and 10, 1887, I have the honor to respectfully recommend that the $11,250 allotted to dredging between the Forks and one-half mile east of Hammond from the $30,000 appropriated for continuing improvement of Calumet River, Illinois, be expended as follows: $5,625 in dredging in the present recognized channel between the Forks and the State line of Illinois and Indiana, at such points and to such depths as will give the greatest relief to the present commerce of the river, these points to be selected as far as practicable from those that are within the limiting lines of the proposed new channel-way for the river; $5,625 in dredging in the river at Hammond, Ind., so as to improve the present channel and form a basin in which vessels that frequent this locality can be turned and handled with greater facility than the present state of the channel will admit of, this dredging to be done within the limiting lines of the proposed new channel-way for the river in this locality.

This recommendation was concurred in by the Chief of Engineers and approved by the Secretary of War. Proposals for doing this dredging were advertised for June 28, and will be opened July 29, 1887.

The estimated cost of the improvement of the lower section of the river so as to provide a channel 200 feet wide and 16 feet deep was $225,000. For the upper section with the same width and depth the estimated cost was $200,000, making a total of $425,000.

These estimates were based upon the assumption that the Government owns its own dredges, and contingent upon the fact that sufficient funds be available at the outset for the purchase of the plant and the performance of one season's work. The estimates submitted for doing the same work by contracts and with insufficient appropriations are, for the lower section of the river, $625,000, and for the upper, $375,000; total, $1,000,000.

It would be far more economical for the Government in this case to purchase its own plant, and after doing the work throw it away, than to adopt the contract policy with small appropriations.

ESTIMATE OF FUNDS FOR THE YEAR ENDING JUNE 30, 1889.

As both sections of the river are now included in the proposed improvement, the estimates therefore are embraced in one item; and for the continuation of the improvement the additional amount of $120,000 is asked.

As the Calumet River and Harbor are so closely connected in their commercial relations no commercial statistics are given in this place.

Money statement.

July 1, 1886, amount available	$50,000.00
Amount appropriated by act approved August 5, 1886	30,000.00
	80,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	772.50
July 1, 1887, amount available	79,227.50

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Amount (estimated) required for completion of existing project..... $345,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 120,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

II 5.

SURVEYS FOR THE HENNEPIN CANAL.

No additional surveys were made during the year for the Hennepin canal or expenses incurred on account of the appropriation therefor which was assigned to this office.

Money statement.

July 1, 1886, amount available	$633.66
July 1, 1887, amount available	633.66

II 6.

PRELIMINARY EXAMINATION OF FARM CREEK, ILLINOIS, WITH A VIEW TO CHANGING ITS COURSE.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 9, 1886.

GENERAL: To comply with the provisions of section 7, river and harbor act approved August 5, 1886, I have the honor to report the following facts and conclusions as the result of a preliminary examination made by me of "Farm Creek, Illinois, with a view to changing its course."

Farm Creek I find is an ordinary and rather insignificant township run, about 12 miles in length, located in Fond du Lac and Washington townships, Tazewell County, Ill. It has the usual characteristics of such streams in this section—dry or nearly so during dry weather, in the rainy seasons overflowing its banks where it can, and bringing down from the bluffs considerable quantities of gravel and sand which it spreads out over the bottom lands. It empties into Peoria Lake near its lower end, opposite the city of Peoria. Its present low-water mouth is perhaps a mile above the lower end of the lake. The stream leaves the bluff about 1½ miles from the lake, and for this distance flows over the bottom lands with no well-defined high-water channel. The evidences are that during its high-water stages the mouth may be anywhere within a reach of 2 miles along this portion of the Illinois River. As a result of this action, the eastern side of the lower end of Peoria Lake seems to be gradually shoaling up with a tendency to extend the river proper further north.

A comparison of the maps in this office showing old soundings with those of recent date does not indicate that this process is working any detriment to the interests of navigation on the west side of the lake.

As there are no navigation interests to be subserved in this locality on the east side, the benefits to the general commerce of the country to be derived from changing the course of Farm Creek are not apparent. From the facts developed during this investigation, I conclude that the

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proposed improvement is not necessary in the interests of commerce, and is not worthy to be undertaken by the General Government.

It might be proper to mention also in this connection that the portion of the Illinois River which it is assumed is to be benefited by the proposed improvement lies within the reach of that river that is controlled by the State of Illinois through its board of canal commissioners. Tolls are collected on its commerce for the benefit of improvements owned by the State.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

117.

PRELIMINARY EXAMINATION OF CALUMET RIVER, ILLINOIS, FROM THE FORKS OF THE RIVER NEAR ITS ENTRANCE INTO LAKE CALUMET TO RIVERDALE, AND ALSO FROM RIVERDALE TO BLUE ISLAND.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., November 16, 1886.

GENERAL: I have the honor to present the following report upon a preliminary examination of the "Calumet River from the forks, near its entrance to Lake Calumet, to Riverdale, and also from Riverdale to Blue Island," as provided for in the river and harbor act of August 5, last.

The stretch of river indicated above is in length about 9¾ miles, and constitutes about 1¾ miles of the upper part of the main river and 8 miles of the lower portion of the Little Calumet.

The latter stream was examined in 1882 and reported upon by me September 9 of that year. (See Report of Chief of Engineers for 1884, page 1951.)

Nothing of special importance can be added to that report, as the general conditions of the river remain unchanged and the industrial interests of the two towns have been but slightly increased since 1882.

In the report above referred to, I stated substantially that while the improvement of the Grand and Little Calumet rivers was not a public necessity I considered that they were worthy of improvement to the points indicated, viz:

Hammond, on the Grand Calumet, and Riverdale, on the Little Calumet, taken in conjunction with the improvement of the main river and harbor then contemplated.

It is intended to make a channel 200 feet wide and 16 feet deep from Lake Michigan to the town of Hammond, and appropriations amounting to $80,000 have been made for that purpose, with the proviso, however, that no work shall be undertaken until the right of way shall have been conveyed to the Government, free of expense, and the United States released from all damages to adjacent property owners. Efforts are being made by parties interested in the improvement to obtain the necessary releases, but as condemnation proceedings must be taken in a number of cases, I consider that quite a length of time must elapse before the work of improvement can be commenced. This latter should undoubtedly be done first, and before any thing is contemplated on the upper river.

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There is a good channel for the present commerce of the Little Calumet River, and it will be sufficient for some years to come, or until the improvement of the lower river is nearing completion; only an occasional lumber vessel now goes to Blue Island. In view of all these circumstances I do not deem that the work is a public necessity, or that the river is worthy of improvement at the present time by the General Government.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

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APPENDIX J J.

IMPROVEMENT OF HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN AND OF GRAND RIVER, BELOW GRAND RAPIDS.

REPORT OF CAPTAIN D. W. LOCKWOOD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charlevoix Harbor and entrance to Pine Lake, Michigan.
2. Frankfort Harbor, Michigan.
3. Harbor of Refuge at Portage Lake, Michigan.
4. Manistee Harbor, Michigan.
5. Ludington Harbor, Michigan.
6. Pentwater Harbor, Michigan.
7. White River Harbor, Michigan.
8. Muskegon Harbor, Michigan.
9. Grand Haven Harbor, Michigan.
10. Grand River, Michigan.
11. Black Lake Harbor, Michigan.
12. Saugatuck Harbor, Michigan.
13. South Haven Harbor, Michigan.
14. Saint Joseph Harbor, Michigan.
15. Michigan City Harbor, Indiana.

EXAMINATIONS.

16. Grand River, Michigan.
17. Pigeon River, Michigan.
18. Carp River, Michigan, at Leland, with a view to affording an entrance to Carp Lake for harbor of refuge.
19. Lake Michigan, at Empire, with a view to cutting a channel across the bar from Lake Michigan to Bar Lake.
20. Grand Traverse Bay, with a view to connecting it with Torch Lake, near Eastport, Mich.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., August 6, 1887.

SIR: I have the honor to submit herewith my annual reports for works of river and harbor improvements under my charge for the fiscal year ending June 30, 1887.

I would respectfully state that it has been impossible to secure the proper commercial statistics for fiscal year ending June 30, 1887.

I have incorporated in this report statistics for the calendar year of 1886.

The report of number of vessels entered and cleared and tonnage of the same is for the fiscal year ending June 30, 1887.

* * * * * * *

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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JJ 1.

IMPROVEMENT OF CHARLEVOIX HARBOR AND ENTRANCE TO PINE LAKE, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan by Round Lake to Pine Lake.

Project.—The project adopted in 1868, and revised in 1875 and 1876, was to dredge a channel 100 to 150 feet wide, and protect its sides by close piling. This was modified in 1876 by substituting crib-work for piling beyond the shore-line. The additional project for channel between Round and Pine lakes was adopted in 1882, and provided for a dredged channel 80 feet wide and 12 feet deep, protected by pile revetment. Present works—north pier, 779 feet long, being 302 feet crib-work 20 feet wide, built in 1879 and 1881; 40 feet crib-work 20 feet wide, and 429 feet crib-work 16 feet wide, built previous to 1873 by local enterprise. The extension of north pier towards Pine Lake is by plank-beam revetment 591 feet in length.

The south pier is 291 feet long, 251 feet being crib-work, 20 feet wide, built in 1885. This pier is extended to Round Lake by a plank-beam revetment 1,493 feet long.

The channel between Round and Pine lakes is protected by pile revetments 12 feet wide; that on the north bank being 339 feet long and that on south bank being 366 feet. The crib-piers are in serviceable condition, but, owing to the fact that the work stated to have been put in by local enterprise previous to 1873 was merely placed upon the natural bottom of the lake, it has never been possible to dredge the channel between the piers to its full width for fear of undermining. The plank-beam revetments are, in some places, particularly on south side of channel, showing evidences of weakness. This is due to the fact that the work was never properly tied back, and pressure from the rear, together with the undermining in front, has, in some places, inclined it towards the channel.

The works in the upper channel are in good order.

Throughout the year a navigable channel, sufficient for the needs of the commerce of the locality, has been maintained from Lake Michigan to Pine Lake.

Operations.—A contract with Luther E. Allen, approved by the Chief of Engineers under date of April 2, 1887, is now in force for—

(1) Building plank-beam revetment (360 feet) from present end of north revetment to bridge, with edging or brush backing.

(2) Dredging in channel below Round Lake, a cut across sand-spit in Round Lake, site of plank-beam revetment, and site of crib.

(3) Placing one crib 20 feet by 50 feet in 12 feet of water in extension of south pier, the superstructure to be six courses high.

The contractor commenced operations June 23, and up to the end of the fiscal year had removed 3,360 cubic yards of sand and gravel from lower channel.

Present depth of water.—Vessels drawing 11 feet have some difficulty in entering and leaving the harbor. The trouble is due to a shoal that of late years has been making out around the end of the south pier, and to shoal places in the channel, caused by propellers getting aground and washing up the bottom with their wheels trying to get off.

The piers and revetments are in serviceable condition. The filling in some cases has settled so as to require renewal, but otherwise only nominal repairs are needed.

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The village council some time ago gave to the Rifenburg Milling Company a site for a grist-mill just below the bridge and located the south face of the building with reference to the proposed north line of the channel. This was done and the mill built without the matter being referred to me in any way. The south face of the building is so near the proposed line of revetment that the owners of the mill fear that in dredging for the site of the revetment the foundation may be undermined, and, as a consequence, threaten legal proceedings to stop the work should they find it necessary to do so to protect their property.

As already stated in previous reports, an extension of the south pier is deemed necessary to intercept a shoal making out from the shore and across the channel. The estimated length of this extension was 300 feet, of which 50 feet is provided for by the present contract with Mr. Allen. The completion of the north revetment in lower channel to the bridge is also very necessary to prevent shoaling in channel from material washed out of the unprotected bank.

It is estimated that $50,000 can be profitably expended during the fiscal year ending June 30, 1889, in extending the south pier, completing revetment in upper channel, and in general repairs to piers and plank beam revetments, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand Traverse. A beacon-light is shown near end of north pier.

Original estimated cost of work, 1868	$198,044.14
Amended in 1876	186,000.00
Whole amount appropriated from 1868 to 1887, inclusive	81,000.00
Whole amount expended	70,710.82

Money statement.

July 1, 1886, amount available		$1,028.11
Amount appropriated by act approved August 5, 1886		10,000.00
		11,028.11
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$656.93	
July 1, 1887, outstanding liabilities	82.00	
		738.93
July 1, 1887, amount available		10,289.18

Amount (estimated) required for completion of existing project	105,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Charlevoix, Mich.

Material in place.	1. W. E. Hutchinson, Saugatuck, Mich.	2. Robert Finch, Grand Haven, Mich.	3. Green's Dredging Co., O. B. Green, president, Chicago, Ill.	4. John Monroe, South Arm, Mich.	5. Luther E. Allen, Charlevoix, Mich.	6. Channcey E. Mitchell, Ludington, Mich.	7. Green Bay Dredge and Pile-Driver Co., Christian Schwarz, president, Green Bay, Wis.
Building plank beam revetment:							
Piles.....per linear foot..	$0.18	.....	$0.30	$0.17	$0.11	.....	$0.17
Timber, B. M.....per M feet..	24.00	.....	25.00	25.00	20.00	.....	27 00
Pine plank, selected, B. M.....do....	20.00	.....	20.00	25.00	15.00	.....	19.50
Pine plank, contractors' option, B. M.....per M feet..	15.00	.....	20.00	15.00	12.00	.....	17.50
Screw and washer bolts per pound..	.06	.....	.06	.07	.05	.....	.06
Cut nails.....do ..	.04½	.....	.06	.04½	.05	.....	.04½
Brush.....per cord..	2.90	.....	4.00	3.00	3.00	.....	3.50
Edgings.....do....	2.90	.....	4.00	2.50	2.50	.....	3.00
Total of material.....	2,193.13	.....	2,938.70	2,178.60	1,703.97	.....	2,288.49
Dredging at—							
Site of revetment....per cubic yard..	.....	$0.35	.20	.....	.18	.22	.28
Site of crib.....do....	.....	.40	.20	.....	.22	.50	.35
In the channel.....do....	.....	.35	.20	.....	.22	.28	.28
In Round Lake.....do....	.....	.35	.20	.....	.18	.24	.29
Total of dredging.....	.....	3,290.00	1,870.00	.....	1,837.00	2,415.00	2,667.50
Construction of crib:							
Oak timber, B. M.....per M feet..	30.00	.....	35.00	50.00	40.00	35.00	42.00
Hemlock timber, B. M.....do...	22.00	.....	25.00	18.00	15.00	18.00	22.00
Pine timber, B. M.....do....	25.00	.....	25.00	30.00	20.00	28.00	27.00
Pine plank, B. M.....do....	20.00	.....	20.00	22.00	15.00	26.00	16.00
Screw-bolts, complete....per pound..	.06	.....	.06	.07	.04	.08	.05½
Drift-bolts.....do....	.05	.....	.06	.04½	.04	.05	.04½
Wrought spike.....do....	.05	.....	.06	.04½	.05	.07	.05½
Stone.....per cord..	10.00	.....	7.00	7.00	9.00	7.50	6.75
Brush.....do....	3.00	.....	4.00	4.00	5.00	3.00	3.50
Total.....	2,611.15	.....	2,473.50	2,277.23	2,122.10	2,316.96	2,282.91

The bid of Luther E. Allen was accepted in the three classes of work.

STATEMENT OF COMMERCIAL STATISTICS, CHARLEVOIX HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	753
Tonnage	151,360

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Entered:		**Cleared:**	
Number of vessels	390	Number of vessels	397
Number of tons	62,932	Number of tons	63,124
Shingles.....thousands..	200,000	Lumber.....feet, B. M..	20,442,000
Lath.....do....	75,000	Shingles.....thousands..	2,070,000
Merchandise and feed.....tons..	2,478	Slabs and wood.....cords..	18,183
Coal.....do....	1,689	Pickets.....thousands..	49,000
Oats and corn.....bushels..	16,091	Railroad ties.....number..	182,113
Groceries.....packages..	18,705	Posts.....do....	63,295
Iron ore.....tons..	37,967	Bark.....cords..	11,112
		Iron ore.....tons..	19,360

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J J 2.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Lake Aux Becs Scies and to make of it a harbor of refuge.

Project.—The present project, adopted in 1866, was to dredge a channel 200 feet wide across the narrow strip of sand separating the two lakes, and extending from the 12-foot curve in one to the 12-foot curve in the other, the sides of the cut to be protected by crib-piers and revetments.

Present work.—On north side of channel there are 602 feet of crib-work 20 feet wide, and 396 feet of pile revetment 14 feet wide. On south side of channel there are 351 feet of crib-work 30 feet wide, 799 feet crib-work 20 feet wide, and 187 feet of pile revetment 14 feet wide. All these works are in a good state of repair.

Depth of water.—The present available depth is 12.9 feet.

Operations.—During the past fiscal year the filling of the inner portion of north revetment was completed for a distance of 396 feet and ballasted with stone. On the south side the filling for a distance of 187 feet from the inner end was also completed and ballasted with stone, and the top course of superstructure for a length of 230 feet renewed and new cross-ties put in. The south pier was extended by the addition of a crib 50 feet long by 30 feet wide on pile foundation. This work was done by contract, Mr. L. E. Allen, of Charlevoix, being the contractor. As stated in previous reports, the lake bottom in advance of the piers, at a depth of about 16 feet, is rocky, and it is believed that if the piers were extended to this depth there would be no further trouble from shoaling at the harbor entrance.

It is estimated that $50,000 can be profitably expended during the fiscal year ending June 30, 1889, in pier extension and such repairs as may become necessary, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is at Point Aux Becs Scies. A pier-light is located near end of south pier.

Original estimated cost of work, 1866, amended in 1875, and again in 1879	$254,196.00
Whole amount appropriated from 1865 to 1887, inclusive	255,659.85
Amount covered into Treasury (Report 1871, page 133)	5,721.50
Whole amount expended	246,189.39

Money statement.

July 1, 1886, amount available		$4,065.63
Amount appropriated by act approved August 5, 1886		7,000.00
		11,065.63
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,196.67	
July 1, 1887, outstanding liabilities	120.00	
		7,316.67
July 1, 1887, amount available		3,748.96

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Amount (estimated) required for completion of existing project	$73,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Frankfort, Mich.

[Pier construction.]

Material in place.	1. Chauncey E. Mitchell, Ludington, Mich.	2. Luther E. Allen, Charlevoix, Mich.
Foundation piles.....per linear feet..	$1.15	$1.00
Sheet-piles.....do....	.35	.30
Oak timber.....per M feet..	40.00	40.00
Hemlock timber.....do....	22.00	22.00
Pine timber.....do....	27.00	26.00
Pine plank.....do..	24.00	25.00
Screw-bolts, complete.....per pound..	.08	.05
Drift-bolts.....do....	.05	.04
Wrought spike.....do....	.07	.06
Stone.....per cord..	12.00	11.00
Brush.....do.	5.00	6.00
Dredging.....per cubic yard..	.75	.75
Total.....	6,402.11	5,873.02

The bid of Luther E. Allen was accepted.

J J 3.

IMPROVEMENT OF HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Portage Lake, such as to make of it a harbor of refuge.

Project.—The original project adopted in 1879 was to dredge a channel 300 feet wide and 18 feet deep connecting the two lakes. The sides of the cut to be protected by pile revetments extending into Lake Michigan by piers of crib-work.

The channel, however, is 370 feet wide.

Present works.—North side of channel 50 feet crib-work, 24 feet wide, and 1,239 feet of pile revetment 14 to 18 feet wide, filled with edgings, ballasted with stone; south side of channel 573 feet pile-work 14 to 18 feet wide, and 805 feet pile revetment 14 feet wide, filled with edgings, ballasted with stone. All this work is in good condition, except a short stretch in each pier where the channel rows of piles were not driven deep enough for an 18-foot channel.

Depth of water.—During the fall and winter the channel made by United States dredge during the summer of 1886 shoaled up so that at the opening of navigation only light-draught vessels could enter.

Operations during year.—Hired labor. The additional filling required in the new revetment south pier was put in this work, being completed July 31, 1886. Altogether 182 cords of edgings were added to the filling, which was in this manner brought up to the bottom of cross-ties. The dredging in the channel by United States dredge *Farquhar*, commenced

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May 16, 1886, was completed July 9, making a channel 50 feet wide and 13 feet deep at low water. On the 20th of June, 1887, the *Farquhar* was again put at work, and at the close of the fiscal year had removed 4,269 cubic yards of sand in re-opening the channel.

By contract.—A contract was entered into with Schwarz & Berner, approved by the Chief of Engineers February 23, 1887, for placing two cribs 50 by 24 feet on pile foundation in extension of north pier. The contractors commenced work on May 20, and at the close of the fiscal year sixteen courses of the first crib and five courses of the second crib had been completed.

Condition of piers.—South side: The old work from west end of new revetment will have to be rebuilt eventually as the piles were only driven to a slight penetration. The new revetment needs additional filling. North side: The revetment is in good condition. The crib at outer end has settled irregularly and requires leveling up.

Until the piers are extended to deep water so that the channel can be excavated to its proposed depth of 18 feet, dredging will be required at comparatively short intervals to accommodate local commerce. As local business improves a deeper-draught class of vessels will be required, and as a consequence more dredging. Sound economy would, therefore, indicate that appropriations for this work should be sufficiently large to complete it within the shortest possible time.

The approved project called for 1,000 feet crib-work 24 feet wide and 200 feet crib-work 30 feet wide to place the outer ends of the piers in water sufficiently deep to prevent shoaling of channel inside.

I would respectfully recommend that $150,000 be appropriated for the fiscal year ending June 30, 1889, as that amount can be economically expended.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Manistee, Mich.

Original estimated cost of work, 1879	$189,860.00
Whole amount appropriated from 1879 to 1887, inclusive	82,500.00
Whole amount expended	70,239.47

Money statement.

July 1, 1886, amount available		$682.22
Amount appropriated by act approved August 5, 1886		15,000.00
		15,682.22
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,870.66	
July 1, 1887, outstanding liabilities	1,551.03	
		3,421.69
July 1, 1887, amount available		12,260.53

Amount (estimated) required for completion of existing project	182,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor of refuge at Portage Lake, Mich.

[Pier construction, 2 cribs.]

Material in place.	1. Stephen Bedford, Manistee, Mich.	2. Luther E. Allen, Charlevoix, Mich.	3. Chauncy E. Mitchell, Ludington, Mich.	4. Schwarz & Berner, Green Bay, Wis.
Foundation piles.....per linear foot..	$1.00	$1.00	$1.15	$0.95
Sheet piles.....do....	.30	.30	.40	.35
Oak timber.....per M feet..	40.00	40.00	40.00	45.00
Hemlock timber.....do....	24.00	20.00	22.00	22.00
Pine timber.....do...	26.00	25.00	27.00	27.00
Pine plank.....do....	20.00	20.00	24.00	19.00
Screw-bolts, complete.....per pound..	.08	.05	.08	.05
Drift-bolts.....do....	.04	.04	.05	.04
Wrought spike.....do....	.08	.06	.07	.05
Stone.....per cord..	10.00	10.50	12.00	8.00
Brush.....do....	6.00	6.00	5.00	5.00
Dredging.....per cubic yard..	1.00	.60	.60	.80
Total, 2 cribs.....	9,663.26	8,848.84	10,036.38	8,597.88

The bid of Schwarz & Berner was accepted.

COMMERCIAL STATISTICS HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared.....	156
Tonnage.....	7,800

Statement of the amount of commerce during the year 1886.

Articles cleared:		
Lumber.....feet B. M..		6,000,000
Bark.....cords..		8,000
Wood.....do...		5,000
Railroad ties.....number..		10,000

JJ 4.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into Manistee River and Lake.

Project.—The project now in force was adopted in 1866 and modified in 1870–'74, and is to secure a channel of navigable width and 12 feet deep, the piers to extend to the 14-foot curve in Lake Michigan. Present width of channel at entrance, 180 feet.

Present work.—(1) North pier 1,048 feet in length, 403 feet being crib-work 24 feet wide, constructed in 1876–'82; 30 feet crib-work 30 feet

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wide, constructed in 1872; 615 feet crib-work 20 feet wide, constructed in 1868–'72. (2) North pile revetment, 1,304 feet long, 14 feet wide, constructed in 1873–'78. The work on north side is badly decayed in places, and requires repairing at once. (3) South pier 1,047 feet crib-work, 150 feet being 30 feet wide, built in 1882–'86; 251 feet 24 feet wide, built in 1876–'79; 30 feet 30 feet wide, built in 1872; and 616 feet 20 feet wide, built in 1868–'72. This work is in fair condition, but needs refilling. The south pile revetment is 490 feet long, 14 feet wide, and should be rebuilt above the water-line.

Depth of water.—During the year a navigable channel of 12 feet depth has been maintained.

Operations.—Hired labor. The broken and decayed portions of timber work in north pier crib-work, as well as in the south pier crib-work, were renewed and filling overhauled in worst parts of revetments on both sides. New filling of edgings and stone were added where most needed. The work was done between August 9 and October 30, 1886, by contract. A contract was entered into with Schwarz & Berner, approved by the Chief of Engineers April 2, 1887, for placing one crib 50 by 30 feet on pile foundation in extension of south pier. The bar at the entrance of this harbor limits the draught of vessels entering and leaving this harbor to about 12 feet. To increase the depth over the bar it will be necessary to revet both sides of the river from the eastern ends of the present revetments to Manistee Lake. The current from this lake to Lake Michigan is so swift that large quantities of sand are carried down and dropped in Lake Michigan just in advance of the piers. As the project in force requires the extension of the piers to the 14-foot curve in Lake Michigan, it is respectfully recommended that $50,000 be appropriated for the fiscal year ending June 30, 1889, to be applied to pier extension and repairs to existing work.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. A light is shown near the head of south pier.

Original estimated cost, 1866, amended 1875	$234,000.00
Whole amount, appropriated 1866 to 1887, inclusive	238,000.00
Whole amount expended	225,108.12

Money statement.

July 1, 1886, amount available	$5,217.32	
Amount appropriated by act approved August 5, 1886	10,000.00	
		15,217,32
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		2,325.44
July 1, 1887, amount available		12,891.88
Amount (estimated) required for completion of existing project		92,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Manistee, Mich.

[Pier construction, one crib.]

Material in place.	1. Stephen Bedford, Manistee, Mich.	2. Henry M. Youmans, East Saginaw, Mich.	3. Chauncey E. Mitchell, Ludington, Mich.	4. Schwarz & Berner, Green Bay, Wis.
Foundation-piles.....per linear foot..	$1.00	$0.90	$1.15	$0.95
Sheet-piles.....do....	.30	.20	.35	.28
Oak timber.....per M feet..	40.00	40.00	40.00	42.00
Hemlock timber.....do....	24.00	25.00	20.00	22.00
Pine timber.....do....	28.00	30.00	27.00	26.00
Pine plank.....do....	20.00	20.00	24.00	19.00
Screw-bolts complete.....per pound..	.08	.05	.08	.05
Drift-bolts.....do....	.04	.05	.05	.04
Wrought spikes.....do....	.08	.05	.07	.05
Stone.....per cord..	10.00	10.00	11.50	8.00
Brush.....do....	7.00	4.00	5.00	4.00
Dredging.....per cubic yard..	1.00	.60	.60	.70
Total.....	6,007.66	5,837.12	6,003.32	5,164.20

The bid of Schwarz & Berner was accepted.

COMMERCIAL STATISTICS, MANISTEE HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	3,412
Tonnage	991,872

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Entered:		Tonnage	470,272
Number of vessels	1,594	Lumber.....feet, B. M..	225,179,000
Tonnage	467,610	Shingles	280,217,000
Merchandise and feed.....tons..	10,030	Lath	17,032,000
Oats and corn.....bushels..	98,161	Slabs and wood.....cord..	1,945
Flour.....barrels..	16,437	Posts.....number..	5,400
Coal.....tons..	5,719	Potatoes.....bushels..	4,450
Cleared:		Salt.....barrels..	748,869
Number of vessels	1,585		

JJ 5.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

Object.—The original object of this improvement was to secure a channel of navigable width and 12 feet deep, between Lake Michigan and Pere Marquette Lake, modified in 1885 so as to make a harbor of refuge.

Present project.—To widen the present entrance to Pere Marquette Lake to 400 feet, and dredge the new channel to a depth of 18 feet. This will necessitate the construction of new south pier and the removal of the present one.

Present works.—(1) North pier, 947 feet long, of crib-work, 200 feet being 24 feet wide, built between 1879 and 1886; and 747 feet 20 feet

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wide, built between 1868 and 1875, with one crib 30 by 30 feet, in this section.

(2) South pier, 1,112 feet crib-work, 256 feet being 30 feet wide, built between 1878 and 1882, and 856 feet built between 1868 and 1874, with one crib 25 by 25 feet, in the last-mentioned section.

(3) South revetment and pile-pier 567 feet long. Both piers are in fair condition.

As already stated, the project now in force provides for the removal of the entire south pier and revetment.

Depth of water.—A navigable channel sufficient for the needs of commerce has been maintained throughout the year.

Operations.—No work was done during the year, in consequence of Congress not authorizing the acceptance, by the United States, of the strip of land required to carry out the present project of widening the entrance to Pere Marquette Lake.

As it is highly important that the work of widening the entrance to 400 feet should be pushed continuously to completion, when once commenced, I would respectfully recommend that $250,000 be appropriated for the fiscal year ending June 30, 1889, as this amount can be economically expended on the work.

This work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich. The nearest light-house is Grand Au Sable. A light is shown near the end of south pier.

Original estimated cost of work, 1866, amended 1879	$213,787.07
And in 1885	419,185.20
Whole amount appropriated from 1866 to 1887, inclusive	292,435.00
Whole amount expended	235,550.52

Money statement.

July 1, 1886, amount available	$1,695.63
Amount appropriated by act approved August 5, 1886	56,250.00
	57,945.63
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,061.15
July 1, 1887, amount available	56,884.48

Amount (estimated) required for completion of existing project	362,935.20
Amount that can be profitably expended in fiscal year ending June 30, 1889	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS, LUDINGTON HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	1,442
Tonnage	259,800

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Entered:		Cleared:	
Number of vessels	683	Number of vessels	686
Flour, tons	61,793	Salt, lumber, and merchandise, tons	80,401
Manufactures, do	2,197		
Grain, do	1,536		
Salt, lumber, and merchandise, do	55,073		

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J J 6.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to Pentwater Lake, which is the harbor of Pentwater.

Project.—The present project, adopted in 1866, is to obtain a channel 150 feet wide and 12 feet deep, protected by piers extending into Lake Michigan and revetments to Pentwater Lake.

Present works.—(1) North pier consists of 402 feet crib-work, of which 233 feet is 30 feet wide and 169 feet 20 feet wide; 428 feet pile-pier 14 feet wide, constructed from 1870 to 1886, and 1,393 feet pile-revetment 14 feet wide. All in fair condition. (2) South pier consists of 619 feet crib-work, of which 32 feet is 32 feet wide, built in 1870, and 587 feet 20 feet wide, built in 1868–'69; also 95 feet pile-pier, 14 feet wide, built in 1872, and 1,297 feet pile-revetment built in 1873–'74. All of the work is in fair condition.

Depth of water.—A navigable channel of about 10 feet depth has been maintained throughout the year.

Operations.—No work was done during the year by hired labor.

Under contract with Mr. Chauncey E. Mitchell, approved by the Chief of Engineers under date of April 2, 1887, a crib 50 feet long by 30 feet wide has been placed on pile foundation in extension of south pier, and at end of fiscal year the superstructure had been raised three courses high.

The old piers and revetments are still in serviceable condition.

The project now in force calls for the extension of the south pier 250 feet, and it is respectfully recommended that $40,000 be appropriated for the fiscal year ending June 30, 1889.

This work is located in the Michigan collection district, Michigan.

The nearest port of entry is Grand Haven, Mich. The nearest light-house is at Little Point Sable; a light is shown near head of south pier.

Original (estimated) cost of work, 1866, amended, 1873	$192,020.00
Whole amount appropriated from 1866 to 1887, inclusive	217,820.00
Whole amount expended	209,791.74

Money statement.

July 1, 1886, amount available		$2,940.16
Amount appropriated by act approved August 5, 1886		10,000.00
		12,940.16
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$791.90	
July 1, 1887, outstanding liabilities	4,120.00	
		4,911.90
July 1, 1887, amount available		8,028.26

Amount (estimated) required for completion of existing project	45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Pentwater, Mich.

[Pier construction—one crib.]

Material in place.		1. Chauncey E. Mitchell, Ludington, Mich.
Foundation-piles	per linear foot	$1.15
Sheet-piles	do	.35
Oak timber	per M feet	40.00
Hemlock timber	do	19.00
Pine timber	do	27.00
Pine plank	do	24.00
Screw-bolts complete	per pound	.08
Drift-bolts	do	.05
Wrought spike	do	.07
Stone	per cord	12.00
Brush	do	5.00
Dredging	per cubic yard	.75
Total		6,099.92

The bid of Chauncey E. Mitchell was accepted.

J J 7.

IMPROVEMENT OF WHITE RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into White Lake, Michigan.

Project.—Adopted in 1866, to dredge a channel 200 feet wide and 12 feet deep between the two lakes, and protect it by parallel piers and revetments.

Present works.—North side, pier and revetment, composed as follows: 45 feet pile-pier, 40 feet wide, built in 1872, repaired 1885–'86; 155 feet pile-pier 20 to 25 feet wide, built in 1872; 256 feet pile-pier, 20 feet wide, built in 1871; 600 feet pile-pier, 14 to 18 feet wide, built in 1870, and 459 feet pile-revetment, 12 to 14 feet wide, built in 1868; superstructure rebuilt in 1886. All in bad condition, except where recently repaired.

South side, composed as follows: 50 feet crib-work, 30 feet wide, constructed in 1882–'83; 51 feet crib-work, 24 feet wide, extended by pile-work in repairs to 30 feet wide in 1881–'83; 255 feet crib-work, 24 feet wide, built in 1876–'81; 367 feet pile-pier, 19 to 24 feet wide, built in 1870–'72; 717 feet pile work, 12 to 14 feet wide, built in 1869–'70; 340 feet repaired in 1885–'86, by building new superstructure, the remainder in bad condition, and 414 feet pile-revetment, 12 to 14 feet wide, in good condition, repaired in 1885–'86.

Depth of water.—Owing to defective revetments, sand leaks, etc., the channel has shoaled so that steamers drawing 9 to 10 feet are obliged to enter and leave stern foremost. There is probably 9 feet available.

Operations.—By hired labor. The superstructure on 459 feet of old pile-revetment, commencing at a point 1,056 feet from outer end of pier and extending east, was rebuilt from a point one-tenth of a foot above the zero of the gauge by sawing off the old piles at that reference, capping them, and placing thereon a regular coursed superstructure with cross-ties 8 feet apart. The work was then filled with edgings to the

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top of lower cross-ties. Plans and estimates have been prepared for rebuilding 695 feet of revetment from the reconstructed pier-head inshore, and contracts awarded for furnishing the necessary material. This work will be commenced at an early date.

There still remains 316 feet of superstructure on north pier to be rebuilt from zero of gauge up, and 377 feet on south side. The filling on south side for a length of 72.3 feet, in addition to above, also requires overhauling and an increase of stone ballast. When the work of repairs is completed the channel should be dredged out.

For continuing pier extension of both piers and renewing entire superstructure of old pile-work not already overhauled above water-line, and overhauling and renewing old filling where needed to stop sand leaks into the channel, $50,000 can be expended to advantage during the fiscal year ending June 30, 1889, and it is respectfully recommended that this amount be appropriated.

This work is located in the Michigan collection district, Michigan, and is situated at the White River Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended 1873	$220,445.56
Whole amount appropriated from 1866 to 1887, inclusive	247,550.00
Whole amount expended	237,347.54

Money statement.

July 1, 1886, amount available		$1,869.98
Amount appropriated by act approved August 5, 1886		10,000.00
		11,869.98
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,663.02	
July 1, 1887, outstanding liabilities	4.50	
		1,667.52
July 1, 1887, amount available		10,202.46
Amount (estimated) required for completion of existing project		84,225.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids received and opened May 25, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for furnishing material at White River Harbor, Michigan.

Material.	1. Kelley, Maus & Co., Chicago, Ill.	2. H. L. Holland, receiver Chicago and Lemont Stone Co., Chicago, Ill.	3. S. D. Kimball, Chicago, Ill.	4. Parkhurst & Wilkinson, Chicago, Ill.	5. Stephen Bedford, Manistee, Mich.
Pine timber, 12 by 12 inches, per M feet	.....	.....	.....	.....	$19 00
Pine plank, 10 by 3 inches, do	.....	.....	.....	.....	18.50
Drift-bolts, per pound	$0.02 4/10	.....	$0.02 33/100	$0.02 33/100	.02 5/10
Wrought spike, do	.....	.....	.03	.03	.04
Edgings, per cord	.....	.....	.....	.....	.....
Stone, do	.....	*$5.50	.....	.....	8.00
Total	273.48	.....	307.07	288.83	4,840.68

* On scows.

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The following awards were made: Stephen Bedford to furnish white pine timber and plank and stone; Kelley, Maus & Co., to furnish iron.

COMMERCIAL STATISTICS WHITE RIVER HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	1,885
Tonnage	262,440

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Entered—		Cleared—	
Vessels	858	Vessels	860
Tonnage	92,078	Tonnage	92,304
Merchandise and feed ..... tons..	2,244	Lumber ....feet B. M..	83,062,000
Corn and oats .....bushels..	46,677	Shingles .....number..	29,435,000
Coal .....tons..	328	Lath .....do....	7,992,000
Flour.....barrels..	1,062	Slabs and wood ..... cords..	14,360
		Pickets .....number..	200,000
		Railroad ties.....do....	93,200
		Posts.....do....	2,500

J J 8.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

Object.—To secure a navigable stream from Lake Michigan to Muskegon Lake, which is the harbor of Muskegon.

Project.—The original project adopted in 1866 was to secure a channel of entrance of navigable width and to extend the piers beyond the bar to 17 feet soundings, modified in 1880 to increase the width of entrance from about 190 to 300 feet by a detached north pier.

Present works.—(1) North pier, outer detached section 351 feet long, crib-work built 1882–'86, in good condition. Inner section old pier, 638 feet crib-work. End crib badly damaged by collisions, 30 feet wide, built in 1880; 70 feet crib-work, 32 feet wide, built 1871–'72, in fair condition; 518 feet crib-work, 20 feet wide, built from 1868–'70. The pile-revetment is 392 feet long, 252 feet being 20 feet wide, and 140 feet 14 feet wide, built 1874–'75. This work is in bad condition and requires complete renewal from the water-line up. (2) South pier, 302 feet crib-work, 30 feet wide, built 1875–'78, in fair condition, excepting pier-head, which has been damaged by collision, 33 feet crib-work, 32 feet wide, built in 1869, in fair condition, and 215 feet crib-work, 20 feet wide, built in 1868, in fair condition. The pile-work inshore is 380 feet long and 20 feet wide, built in 1872–'74. This work should be entirely renewed above the water-line, as it is in a badly decayed condition.

Depth of water.—Least available depth between piers 14. About 700 feet out beyond the piers there is a bar with only 13.5 feet depth.

Operations.—By hired labor. The end of old north pier, which had been seriously damaged in the past by collision and undermining, was repaired by placing a jacket over the submerged outer end and building a superstructure on it, bonded back to the old work. The outer

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half of the end crib was surrounded by piles driven 2 feet apart and sawed off at the level of the top of superstructure, to which they were fastened by screw-bolts. A wale-streak was put on at the water-surface and a fender-streak at top of work. One crib interval was closed by vertical timbers at front and rear walls and refilled. A part of the old revetment was repaired, and several washouts repaired by overhauling the filling and replacing it.

By contract.—A contract was entered into with Schwarz & Berner, approved by the Chief of Engineers, under date of April 2, 1887, for placing 2 cribs, each 50 feet long by 30 feet wide, on pile foundation in extension of north detached pier.

The contractors commenced work June 6, 1887, and at the close of fiscal year sixteen courses of one crib had been completed. During the severe storms of last fall considerable damage was done to the slab revetment on south side of channel, inside of the Government work. As this was occupied as a lumber dock it has been repaired by the parties interested.

Work required on present piers. New superstructure on south pile revetment for a length of 350 feet. On north side two crib intervals in detached pier need refilling, as well as two in the old north pier. New superstructure is also required on 392 feet of pile revetment.

To complete the improvement at this harbor in accordance with the present project, it is estimated that $101,125 will be required, and I would respectfully recommend that $100,000 of this amount be appropriated for the fiscal year ending June 30, 1889.

This work is located in the Michigan collection district, Michigan, and is situated at the Muskegon Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866, amended 1879	$168,901.75
Whole amount appropriated from 1866 to 1887, inclusive	234,000.00
Whole amount expended	219,427.20

Money statement.

July 1, 1886, amount available		$6,296.67
Amount appropriated by act approved August 5, 1886		12,500.00
		18,796.67
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,878.33	
July 1, 1887, outstanding liabilities	345.54	
		4,223.87
July 1, 1887, amount available		14,572.80

Amount (estimated) required for completion of existing project	101,125.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Muskegon, Mich.

[Pier construction, two cribs.]

Material in place.	1. Henry M. Youmans, East Saginaw, Mich.	2. Chauncey E. Mitchell, Ludington, Mich.	3. Hiero B. Herr & Co., Chicago, Ill.	4. Wm. McMillan, Muskegon, Mich.	5. Schwarz & Berner, Green Bay, Wis.
Foundation piles.....per linear foot..	$0.90	$1.15	$1.00	$0.99	$0.95
Sheet piles.....do....	.20	.35	.35	.19	.28
Oak timber.....per M feet..	40.00	40.00	45.00	30.00	42.00
Hemlock timber.....do....	25.00	22.00	27.00	19.50	21.00
Pine timber.....do....	30.00	28.00	30.00	23.00	26.00
Pine plank.....do....	20.00	26.00	28.00	16.00	19.00
Screw bolts, complete.....per pound..	.05	.08	.06	.05	.05
Drift bolts.....do....	.05	.05	.06	.05	.04
Wrought spike.....do....	.05	.07	.06	.05	.05
Stone.....per cord..	10.00	12.00	12.00	12.00	9.25
Brush.....do....	4.00	5.00	4.00	3.00	4.00
Dredging.....per cubic yard..	.60	.60	.50	.40	.48
Total.....	11,674.24	12,537.84	13,248.42	11,184.42	10,502.90

The bid of Schwarz & Berner was accepted.

COMMERCIAL STATISTICS MUSKEGON HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	1,745
Tonnage	232,007

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Entered:		Cleared—continued:	
Number of vessels	2,162	Shingles	150,504,125
Tonnage	525,095	Lath	22,830,000
Cleared:		Slabs and wood.....cords..	259,608
Number of vessels	2,152	Pickets.....M..	12,250
Tonnage	551,803	Posts.....number..	208,315
Lumber.....feet, B. M..	141,461,000	Bark.....cords..	455

J J 9.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

Object.—To secure a channel navigable in any weather from Lake Michigan into Grand Haven Harbor, which is a port of Grand River.

Project.—The project in force at present was adopted in 1866, and provides for securing a channel of navigable width (400 feet) with an available depth of 18 feet.

Present works.—First, north pier, 1,210 feet long, 608 feet being crib-work, built in 1875–'79, and 602 feet pile work, 20–22 feet wide, built

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1875, all in fair condition. North revetment in continuation of pier 1,526 feet long, pile work 14 feet wide, built 1874. The outer 726 feet is now being rebuilt from the water-line up. The remaining 800 feet was rebuilt in the same manner during 1884–'85. Second, south pier 2,435 feet long, 601 feet being crib-work, 30 feet wide, built in 1882–'86, in good condition, except end crib, which has settled and requires new superstructure; 102 feet crib-work, 24 feet wide, built in 1869, and 294 feet crib-work 20 feet wide, 1868–'70. These two sections were widened to 30 feet by a double row of close piling for new lake face, and new superstructure of that width, in good condition; 1,438 feet pile work, 15 to 30 feet wide, in poor condition, built 1866 to 1871; partly repaired (310 running feet) in 1883.

The south revetment, in continuation of the above, is 2,834 feet long, of pile work 14 feet wide, built 1873–'82; in fair condition. Depth of water: An available depth of 18.5 feet, between the piers, has been maintained throughout the year, with 17 feet over the bar outside.

Operations.—The work on new superstructure of north pier, commenced June 8, 1886, was completed November 20, 1886. During the same period a number of breaks in the channel-face of north pier were closed and refilled with stone. A contract was entered into with Schwarz & Berner, approved by the Chief of Engineers April 2, 1887, for placing 1 crib 50 feet long by 30 feet wide, on pile foundation, in extension of south pier, and 3 cribs of the same dimensions on pile foundation in extension of north pier. The contractors commenced work May 2, 1887, and at the close of the fiscal year the following work had been done: 1 crib built up to 18 courses, 2 cribs built up to 20 courses each. The crib-site had been dredged and piles for 3 cribs driven.

The permanent completion of this harbor depends upon the extension of the present piers, so as to secure sufficient depth of water at the entrance to permit vessels to enter in any weather, and I would respectfully recommend that $150,000 be appropriated for the fiscal year ending June 30, 1889, in order to carry out this plan at as early a date as possible.

This work is located in the Michigan collecti on district, Michigan, and is situated at the Grand Haven Lights.

Grand Haven is a port of entry.

Original estimated cost of work, 1866	$352,770.47
Whole amount appropriated from 1852 to 1887, inclusive	524,366.15
Whole amount expended	486,434.93

Money statement.

July 1, 1886, amount available		$13,721.73
Amount appropriated by act approved August 5, 1886		30,000.00
		43,721.73
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$5,663.31	
July 1, 1887, outstanding liabilities	127.20	
		5,790.51
July 1, 1887, amount available		37,931.22
Amount (estimated) required for completion of existing project		180,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at Grand Haven, Mich.

[Pier construction, four cribs.]

Material in place.	1. Hiero B. Herr & Co., Chicago, Ill.	2. Thomas W. Kirby, Grand Haven, Mich.	3. Castle Sutherland, East Saginaw, Mich.	4. Robert Finch, Grand Haven, Mich.	5. Schwarz & Berner, Green Bay, Wis.
Foundation piles.....per linear foot..	$1.00	$0.90	$0.90	$0.95	$0.95
Sheet piles.....do ..	.35	.22	.20	.25	.28
Oak timber.....per M feet..	35.00	30.00	40.00	35.00	42.00
Hemlock timber.....do....	23.00	24.00	25.00	24.00	22.00
Pine timber.....do....	29.00	28.00	30.00	27.00	27.00
Pine plank.....do....	27.00	22.00	20.00	22.00	20.00
Screw-bolts, complete .....per pound..	.06	.06	.05	.07	.05
Drift-bolts.....do....	.05	.05	.03	.05	.03½
Wrought spike.....do....	.06	.06	.05	.05	.05
Stone.....per cord..	11.00	12.00	10.00	11.50	9.25
Brush.....do....	3.00	4.00	4.00	4.00	4.00
Dredging.....per cubic yard..	.50	.40	.60	.50	.38
Total.....	24,842.40	24,265.56	23,348.48	24,156.64	21,117.68

The bid of Schwarz & Berner was accepted.

COMMERCIAL STATISTICS, GRAND HAVEN HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared.....	1,297
Tonnage.....	632,159

Statement of the amount of commerce during the year 1886.

Articles.	Quantity.	Articles.	Quantity.
Cleared:		Entered:	
Number of vessels.....	632	Number of vessels.....	632
Tonnage.....	324,159	Tonnage.....	328,817
Lumber.....feet, B. M..	57,057,593	Merchandise and feed.....tons..	109,578
Shingles.....M..	29,435,000	Flour.....barrels..	931,806
Lath.....M..	67,000	Oil-cake.....sacks..	43,828
Slats and wood.....cords..	7,772	Bullion.....tons..	2,983
Iron ore.....tons..	41,520	Iron ore.....do..	41,520
Fruit.....baskets and barrels..	150,777	Pig-iron.....do..	8,096
Merchandise.....packages..	306,319		
Pig-iron.....tons..	16,972		

J J 10.

IMPROVEMENT OF GRAND RIVER, MICHIGAN.

Object.—The object of this improvement is to afford easy navigation for light-draught boats between Grand Rapids and the river's mouth.

Project.—The project now in force was approved by the Chief of Engineers, U. S. Army, under date of January 23, 1885, and is to dredge a cut 60 feet wide and 4.5 feet deep. On the line indicated on tracing of map of survey this line followed practically the line of deepest water.

Operations.—At the commencement of the fiscal year a contract for

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dredging was in force with Mr. Robert Finch. The prices to be paid for material removed being, for sand, clay, and gravel 25 cents per cubic yard and for bowlders 30 cents per cubic yard, measured on the lighters.

The dredging was carried down-stream to the foot of Haire's Bar by July 22, 1886, and after the contractor had removed some large bowlders from the edge of the cut near the Lake Shore Railroad Bridge the contract was closed, the appropriation being exhausted; 6,157.77 cubic yards of sand, clay, and gravel were removed.

The improvement covered 11 miles and 1,130 yards of the river, and extended from the foot of Ganoe's Canal to the foot of Haire's Bar.

The channel dredged out is not considered permanent.

No further appropriation is recommended.

The work is located in the Michigan collection district, Michigan. The nearest light-house is at Grand Haven, Mich. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of dredging, 1881	$25,000
Whole amount appropriated from 1881 to 1887, inclusive	50,000
Whole amount expended	50,000

Money statement.

July 1, 1886, amount available	$1,709.89
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,709.89

JJ 11.

IMPROVEMENT OF BLACK LAKE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into Black Lake, Michigan.

Project.—The present project was adopted in 1866 and modified in 1873, and provides for a channel of navigable width and not less than 12 feet deep.

Present works.—(1) North pier, 713 feet long, as follows: 253 feet crib-work, 24 feet wide, built in 1875–'80, in good condition; 32 feet crib-work, 32 feet wide, built in 1871, with superstructure 24 feet wide, built 1885, in good condition; 259 feet crib-work, 20 feet wide, built 1868–'69, end crib resuperstructured in 1884, in good condition; 123 feet crib-work of irregular width, built previous to 1866, resuperstructured in 1884, in good condition; and 46 feet of crib-work, 20 feet wide, built in 1868, resuperstructured in 1884, in good condition. The north revetment, in continuation of the above, is 1,137 feet long, of pile-work, 549 feet being 14 feet wide, built in 1870, and 588 feet 16 feet wide, built in 1870–'73; 34 feet of this revetment was rebuilt above the water-line in 1884; the remainder is in very bad shape. (2) South pier, 691 feet crib-work, 252 feet being 24 feet wide, built 1875–'80, end crib resuperstructured 1885–'86, in good condition; 298 feet 20 feet wide, built 1868–'70, resuperstructured in 1885; 77 feet of irregular width, resuperstructured in 1885, in good condition; 64 feet 20 feet wide, built in 1868, resuperstructured in 1885, in good condition; and 150 feet pile-pier, 14 feet wide, built in 1870 and resuperstructured in 1885.

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The revetment in continuation of south pier is 707 feet long, of pile-work 14 feet wide, built 1871–'74, in bad condition, except 101 feet, which was resuperstructured in 1886.

The old wing, 323 feet long, is not regarded as of sufficient importance to the improvement to warrant any work of repair being done to it.

Present depth of water.—In the channel midway between the piers there is a least depth of 9 feet, while on either side near the piers the water is not less than 10 feet deep. On the outer bar there is not less than 14 feet. At the time the above depths were determined the gauge read 1.3 feet above zero.

Operations during the year.—Estimates and plans have been prepared for rebuilding superstructure on north pile revetment for a length of 515 feet and contracts entered into for furnishing the necessary material, the work to be done by hired labor.

No further pier extension is contemplated at this harbor, but the old revetments are in such a tumble-down condition as to require complete renewal above the water-line. At present the extent of this work is as follows: On north side of channel 1,103 feet; on south side of channel 605 feet to be resuperstructured, and 150 feet of revetment to be rebuilt practically complete. The funds available are sufficient to resuperstructure about 500 feet of the above, and as already stated contracts are now in force for securing the necessary material for doing this.

It is estimated that $15,000 will complete the work at this harbor, and it is respectfully recommended that this amount be appropriated for the fiscal year ending June 30, 1889.

This work is located in the Michigan collection district, Michigan, at Holland Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work 1886	$106,238.04
Whole amount appropriated from 1852 to 1887, inclusive	259,615.31
Whole amount expended	252,854.26

Money statement.

July 1, 1886, amount available	$2,235.00	
Amount appropriated by act approved August 5, 1886	5,000.00	
		7,235.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		473.95
July 1, 1887, amount available		6,761.05
Amount (estimated) required for completion of existing project		15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids received and opened May 25, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for furnishing material at harbor at Black Lake, Michigan.

Number.	Name and address of bidders.	White pine timber.		Drift-bolts.		Edgings.		Brush.		Stone.	
		Per M feet.	Total.	Per pound.	Total	Per cord.	Total.	Per cord.	Total.	Per cord.	Total.
				Cents.							
1	Isaac F. Geer, Saugatuck, Mich	.....	.....	.....	.....	$3.25	$568.75	$2.90	$507.50	.....	.....
2	Parkhurst & Wilkinson, Chicago, Ill	.....	.....	2.59	$183.40	.....	.....	.....	.....	.....	.....
3	S. D. Kimbark, Chicago, Ill	.....	.....	2.6	189.09	.....	.....	.....	.....	.....	.....
4	Oscar E. Yates, Holland, Mich	.....	.....	.....	.....	.....	.....	.....	.....	$7.75	$751.75
5	Stephen Bedford, Manistee, Mich	$19.50	$1,710.07	2.5	172.20	.....	.....	.....	.....	8.00	7.76
6	John Nies, Saugatuck, Mich	.....	.....	3.15	216.97	.....	.....	.....	.....	.....	.....
7	Kelley, Maus & Co., Chicago, Ill	.....	.....	2.4	165.31	.....	.....	.....	.....	.....	.....
8	H. L. Holland, receiver Chicago and Lemont Stone Company, Chicago, Ill	.....	.....	.....	.....	.....	.....	.....	.....	*5.50	.....

*On scows, Chicago, Ill.

Following bids were accepted: Isaac F. Geer's, for brush or edgings; Stephen Bedford's, for stone and pine timber; Kelley, Maus & Co.'s, for drift-bolts. The stone which Oscar E. Yates proposed to furnish was not suitable for pier filling.

J J 12.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to the harbor of Kalamazoo River, Michigan.

Project.—The present project is to merely maintain existing works and to keep a channel of entrance 10 feet deep by dredging.

Present works.—(1) North pier: 375 feet pile-work 14 to 18 feet wide, built in 1875, in poor condition. The north revetment in continuation of pier is 339½ feet long, of pile-work, 14 feet wide, built in 1875–'76. Around the bend of the river there is a revetment of pile-work 1,193 feet long, 12 feet wide, in poor condition, the up-stream part being covered with sand. The interval between the revetments is 1,750 feet. (2) South pier: Two hundred and eighty-six feet of pile-work, 20 feet wide, built in 1874, in poor condition. The south revetment is 3,577 feet long, 834 feet being 24 feet wide, and the balance 14 feet wide. This work is of pile construction, built 1870–'73, and is in a very dilapidated state; in fact, all the works are in such a state that complete renewal above the water-line is indicated.

The depth of water is such as to permit vessels drawing 8.5 feet to enter, but the channel is a difficult one and will remain so so long as the piers are not extended further into Lake Michigan.

Operations during the year.—Estimates and plans have been prepared for rebuilding the south revetment above the bend, and contracts entered into for furnishing the necessary material. The work will be done by hired labor.

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The entire timber work at this harbor is in a more or less dilapidated condition, and to maintain even the "existing condition of the improvement," all that is at present contemplated, will in a few years require additional appropriations.

The stretch of the river from Singapoor to where the revetment commences is parallel to the beach of Lake Michigan and separated from it only by a sand ridge. As a consequence, westerly winds continually blow sand into the channel, which is carried down by the current to be dropped on the bar.

No work was done during the fiscal year ending June 30, 1887.

This work is located in the Michigan collection district, Michigan, and is situated at the Kalamazoo Light. The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866 modified 1869	$86,398.56
Whole amount appropriated from 1868 to 1887, inclusive	135,439.00
Whole amount expended	124,790.48

Money statement.

July 1, 1886, amount available		$3,355.22
Amount appropriated by act approved August 5, 1886		8,000.00
		11,355.22
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$676.70	
July 1, 1887, outstanding liabilities	30.00	
		706.70
July 1, 1887, amount available		10,648.52
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		5,000.00

Abstract of bids received and opened May 25, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for furnishing material at harbor at Saugatuck, Mich.

No.	Name and address of bidders.	White pine timber.		Pine piles.		Drift-bolts.		Brush.		Stone.	
		Per M feet.	Total.	Per linear foot.	Total.	Per pound.	Total.	Per cord.	Total.	Per cord.	Total.
1	Isaac F. Geer, Saugatuck, Mich			Cts 15	$681.50	Cts.		$2.90	$290	$9.50	$380
2	Parkhurst & Wilkinson, Chicago, Ill					2.49	$524.42				
3	S. D. Kimbark, Chicago, Ill					2.6	547.58				
4	Oscar E. Yates, Holland, Mich									7.85	314
5	Stephen Bedford, Manistee, Mich	$19.50	$3,528.26	13	590.72	2.5	526.52			8.00	320
6	John Nies, Saugatuck, Mich					3	631.83				
7	Kelley, Maus & Co., Chicago, Ill					2.4	505.46				
8	H. L. Holland, receiver Chicago and Lemont Stone Company, Chicago, Ill									*5.50	

* On scows, Chicago.

The following bids were accepted: Isaac F. Geer's for brush, Stephen Bedford's for timber, piles, and stone, Kelley, Maus & Co.'s for iron. The stone which Oscar E. Yates proposed to furnish was not suitable for pier filling.

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Statement of amount of commerce during the year 1886.

SHIPMENTS.

Peaches	bushels..	190,6[illegible]
Berries	crates..	17,0[illegible]
Apples	barrels..	7,5[illegible]
Potatoes	sacks..	1,8[illegible]
Flour	barrels..	1,0[illegible]
Fish	pounds..	200,0[illegible]
Caviare	do....	50,0[illegible]
Timber	feet..	3,000,0[illegible]

RECEIPTS.

General merchandise	valued at..	$200,0[illegible]
Drain tile	tons..	20
Coal	do....	20

J J 13.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into South Black River, Michigan, which is the harbor of South Haven.

Project.—The present project, adopted in 1866 and modified in 1879, was to obtain a channel of navigable width and not less than 14 feet deep.

Present works.—(1) North pier: 606 feet crib-work, 255 feet being 32 feet wide, built 1872–'74; 30 feet 30 feet wide, built in 1871, and 321 feet 20 feet wide, built in 1868–'69, all in fair condition. The north revetment in continuation of pier is 986 feet long, 524 feet being pile-work, 14 feet wide, built in 1876; and 462 feet plank-beam, built in 1879, in serviceable condition. (2) South pier: 502 feet crib-work, 150 feet being 32 feet wide, built in 1871–'74; 352 feet 20 feet wide, built in 1868, in fair condition.

The south revetment is 998 feet long, 143 feet being pile-work, 14 feet wide, built 1878, and 855 feet plank-beam, built 1878–'82, in serviceable condition.

Depth of water.—On the bar there is 14 feet, between the piers 11.5 feet, and to the railway dock 10.5 feet.

Operations during the year.—A contract was entered into with H. B. Herr & Co., approved by the Chief of Engineers, U. S. Army, April 2, 1887, for placing one crib 50 feet long by 30 feet wide on pile foundation in extension of south pier. The contractors commenced work on this crib June 14, 1887, and at the close of the fiscal year 14 courses of the crib had been built, the site for the crib dredged, and the foundation piles driven and sawed off at the proper elevation.

There still remains a considerable amount of dredging to be done. The piers and revetments require to have their filling overhauled to make it sand tight, and, in addition, pier extension is indicated with a view of securing deeper water between the piers. It is respectfully recommended that $40,000 be appropriated for the fiscal year ending June 30, 1889, for the purposes mentioned.

This work is located in the Michigan collection district, Michigan, and is situated at the South Haven Light.

The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work, 1866	$128,288.47
Whole amount appropriated from 1866 to 1887, inclusive	182,000.00
Whole amount expended	172,218.06

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Money statement.

July 1, 1886, amount available		$5,548.61
Amount appropriated by act approved August 5, 1886		5,000.00
		10,548.61
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$706.67	
July 1, 1887, outstanding liabilities	60.00	
		766.67
July 1, 1887, amount available		9,781.94

Amount (estimated) required for completion of existing project	$77,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids received and opened February 15, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for improving harbor at South Haven, Mich.

[Pier construction, one crib.]

Material in place.		Hiero B. Herr & Co., Chicago, Ill.
Foundation piles	per linear foot	$1.00
Sheet piles	do	.40
Oak timber	per M feet	45.00
Hemlock timber	do	28.00
Pine timber	do	32.00
Pine plank	do	30.00
Screw-bolts, complete	per pound	.07
Drift-bolts	do	.06
Wrought spike	do	.06
Stone	per cord	12.00
Brush	do	5.00
Dredging	per cubic yard	1.00
Total		7,033.23

The bid of Hiero B. Herr & Co. was accepted.

COMMERCIAL STATISTICS, SOUTH HAVEN HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	264
Tonnage	52,800

Statement of the amount of commerce during the year 1886.

Articles.	Quantities.	Articles.	Quantities.
Cleared:		Entered:	
Lumber, feet	455,000	Lumber, feet	190,000
Slabs and wood, cords	1,509	Shingles	170,000
Potatoes, bushels	21,132	Laths	160,000
Fruit, baskets and barrels	234,685	Merchandise, packages	27,026
Merchandise, packages	63,415		

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J J 14.

IMPROVEMENT OF SAINT JOSEPH HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan to the harbor of Saint Joseph, Mich.

Project.—The present project was adopted in 1866 and modified in 1874, and is to secure a channel of entrance of navigable width and not less than 16 feet deep.

Present works.—(1) North pier, from outer end to angle, 456.7 feet crib-work, 100 feet being 30 feet wide, built 1880–'81, the balance 24 feet wide, built 1875–'78, all in good condition. From the angle inshore there is a section of crib-work 24 feet wide, which for 242 feet is in fair condition. The next section of 131 feet is still serviceable, although it should be rebuilt within a year or two. Thence inshore extends the north revetment, built last fall. (2) South pier, 666 feet pile-work, 25 feet wide, 416 feet of which was built 1871–'72; 200 feet, 1867–'68, and 50 feet built prior to 1866. This work has been repaired from time to time, but is in a precarious condition at present.

The south revetment, built prior to 1866, is 162 feet long, of pile-work, and it is in poor condition.

The north bank of the Benton Harbor Canal was revetted by the Cincinnati, Wabash and Michigan Railway Company in 1882.

By the terms of the original agreement the company was to revet the entire north bank in consideration of the United States widening the canal beyond what was called for by the original project. The United States constructed, in 1881 and previous years, 1,585 feet of plank-beam revetment on the north bank of the canal, joining at its western end the wing-dam, 720 feet long, built 1874–'79. The wing-dam is in fair condition, but the plank-beam can hardly be called serviceable at present.

Depth of water.—Across the bar and to the railway bridge there is a depth of 14 feet. In the canal there is an available depth of 11 feet.

Operations.—As already stated, 696 feet of pile revetment was built last fall on the north side of the channel. This spring the work required some repairs, the filling having been considerably shaken up by storms during the winter. During the winter the United States tug-dredge and dump-scows received a thorough overhauling at this harbor, and near the close of the fiscal year the work of renewing the superstructure of south pier was commenced. All work done during the year was by hired labor, using purchased material.

To carry out the present plan of improvement for the harbor proper of Saint Joseph below the railway bridge, it is estimated that $41,015 will be required, and I would respectfully recommend that this amount be appropriated for the fiscal year ending June 30, 1889.

This work is located in the Michigan collection district, Michigan, and is situated at the Saint Joseph Light.

The nearest port of entry is Grand Haven, Mich.

Original estimated cost of work as now being carried on	$128,288.47
Whole amount appropriated since adoption of present project, from 1836 to 1887, inclusive	342,613.00
Transferred to Grand Haven (Report, 1870, page 44)	500.00
Whole amount expended	337,568.43

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Money statement.

July 1, 1886, amount available		$14,638.86
Amount appropriated by act approved August 5, 1886		10,000.00
		24,638.86
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$19,838.72	
July 1, 1887, outstanding liabilities	255.57	
		20,094.29
July 1, 1887, amount available		4,544.57
Amount (estimated) required for completion of existing project		41,015.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		41,015.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1856 and 1867.		

Abstract of bids received and opened September 8, 1886, by Capt. D. W. Lockwood, Corps of Engineers, for furnishing material at Saint Joseph Harbor, Mich.

No.	Name and address of bidders.	Piles, Norway, 24 feet long.		White pine timber, 12 by 12 inches.		Pine plank, 3 by 10 inches.	
		Per linear foot	Total.	Per M feet.	Total.	Per M feet.	Total.
		Cents.					
1	H. L. Holland, receiver Chicago and Lemont Stone Company, Chicago, Ill	.....	.....	.....	.....	.....	.....
2	Leathern & Smith, Sturgeon Bay, Wis	$0.13	84.00	.....	.....	$12.00	$342.40
3	Kelley, Maus & Co., Chicago, Ill	.....	.....	.....	.....	.....	.....
4	D. S. Kimbark, Chicago, Ill	.....	.....	.....	.....	.....	.....
5	Thomas W. Kirby, Grand Haven, Mich	.....	.....	.....	.....	.....	.....
6	H. L. Green, Chicago, Ill	.....	.....	.....	.....	.....	.....
7	Excelsior Stone Company, Chicago Ill	.....	.....	.....	.....	.....	.....
8	Albert H. Petrie, Muskegon, Mich	.16	96.00	$16.95	2,024.24	13.95	630.54
9	J. M Allmendinger, Benton Harbor, Mich	.12.50	75.00	23.00	2,985.60	15.00	678.00

No.	Name and address of bidders.	Drift-bolts, 1 inch square.		Wrought spikes.		Stone.	
		Per pound.	Total.	Per pound.	Total.	Per cord.	Total.
		Cents.		*Cents.*			
1	H. L. Holland, receiver Chicago and Lemont Stone Company, Chicago, Ill	.....	.....	.....	.....	$9.75	$4,231.50
2	Leathern & Smith, Sturgeon Bay, Wis	.....	.....	.....	.....	.....	.....
3	Kelly, Maus & Co., Chicago, Ill	2.25	$222.55	2.55	$53.88	.....	.....
4	S. D. Kimbark, Chicago, Ill	2.25	225.55	2.45	51.77	.....	.....
5	Thomas W. Kirby, Grand Haven, Mich	.....	.....	.....	.....	9.35	4,057.90
6	H. L. Green, Chicago, Ill	2.10	207.71	.....	.....	.....	.....
7	Excelsior Stone Company, Chicago, Ill	.....	.....	.....	.....	9.74	4,227.16
8	Albert H. Petrie, Muskegon, Mich	.....	.....	.....	.....	10.95	4,752.30
9	J. W Allmendinger, Benton Harbor, Mich	3.25	321.48	3.25	68.65	.....	.....

The following bids were accepted: Leathern & Smith's, for plank; S. D. Kimbark's, for iron; Thomas W. Kirby's, for stone; Albert H. Petrie's, for pine timber, and J. M. Allmendinger's, for piles.

COMMERCIAL STATISTICS, SAINT JOSEPH HARBOR, MICHIGAN, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	580
Tonnage	144,000

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Statement of the amount of commerce during the year 1886.

Articles.	Quantities.	Articles.	Quantities.
Cleared:		Entered:	
Lumber.....feet..	145,000	Lumber.....feet..	1,690,000
Potatoes.....bushels..	40,080	Groceries.....packages..	12,311
Fruits.....baskets..	280,210	Flour.....bbls..	341
Merchandise.....packages..	57,366		

J J 15.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

OUTER HARBOR.

Object.—To secure a harbor of refuge suitable for all classes of vessels engaged in commerce on the lakes.

Project.—The first project for an exterior harbor to the east of entrance was adopted in 1870 and modified in 1872, 1875, 1876, and 1877. The second project, for a western breakwater, was adopted in 1882.

Operations.—No work was performed at this harbor until October, 1886, except to take proper care of the United States engineer property and maintain the lights at the breakwater. During October the stone scows were overhauled and caulked. The beacon light having been abandoned by the Light-House Department on account of the dilapidated condition of the west pier, a temporary light was established there by the United States Engineer Department.

During a severe gale on the 14th of October the lantern and its support, together with the beacon and a large part of the superstructure, were carried away, and after that the light was abandoned.

During the early part of November the work of repairing the west pier was commenced. The damaged work was leveled with the water-surface and two courses of superstructure put on, the whole being filled with stone excepting the last 50 feet, which became filled with solid ice.

During the months of December and January ways were laid at the lower basin and the pile-driver and two dump-scows were hauled out for repairs; they were cut down to the bottoms and thoroughly rebuilt and launched. The steam hammer and dredge machinery have also been put in a thorough state of repair. At west pier the low work has been brought up to water-surface, some parts requiring to be raised 9 feet, which was done by the diver. The work has been thoroughly filled with stone, a large part of which was cast up by the dredge along the east face of the pier.

The United States pile-driver has been employed driving piles for west pile-pier. It is contemplated to drive a single row of piling around the work. The driving was in some places very hard, being through stone and hard pan.

At the close of the fiscal year 33 piles had been driven on the west side of the pier and 23 piles on the east side.

Cribs Nos. 1 and 2 of the main breakwater require rebuilding from the water-line up at once, and the superstructure of all, up to and including No. 12, are in an advanced state of decay. The decking throughout requires renewing and about 250 cords of stone will be required to refill the pockets that are empty, or partially so.

The channel is in good condition to Sixth Street Bridge, except at the Michigan Central Railroad Bridge and a point near the old east

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pier, where there is a shoal area of limited extent with a depth of only 14½ feet.

Estimates.—To complete the new east breakwater pier and construct the west exterior breakwater, in accordance with the report of the Board of Engineers constituted by Special Orders, No. 19, Headquarters Corps of Engineers, U. S. Army, dated Washington, D. C., March 2, 1882, to consider and report upon the improvement of the harbor at Michigan City, Ind., it was estimated by Major Smith that it would require $450,000 (page 1968, Report of Chief of Engineers, 1884); and as the construction of the breakwater, when once commenced, should be pushed to completion as rapidly as possible, I would respectfully recommend that $250,000 be appropriated for the fiscal year ending June 30, 1889, to be applied to construction of west exterior breakwater, completion of the breakwater pier at entrance, and the renewal of superstructure and filling of old west pier. The views and recommendation of the Board of Engineers mentioned above were concurred in by the Chief of Engineers, under date of July 6, 1882.

The work is located in the collection district of Chicago. The nearest light-house is Michigan City. The nearest port of entry is at Chicago, Ill.

Original estimated cost of work, 1857, amended 1870 and 1882	$587,000.00
Whole amount appropriated from 1836 to 1887, inclusive	868,793.59
Whole amount expended	830,396.00

Money statement.

July 1, 1886, amount available		$5,137.71
Amount appropriated by act approved August 5, 1886		54,375.00
		59,512.71
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$18,675.98	
July 1, 1887, outstanding liabilities	2,439.14	
		21,115.12
July 1, 1887, amount available		38,397.59
Amount (estimated) required for completion of existing project		395,625.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

INNER HARBOR.

Object.—To obtain a suitable harbor for vessels by dredging Trail Creek.

Project.—The first project was adopted in 1870, and provided for deepening the channel up to the railroad bridge. The second project was adopted in 1878, and provided for making the length of the inner harbor 2,700 feet, its width 120 feet, and its depth 15 feet.

Operations.—During the year one cut, 550 feet long and 35 feet wide, was dredged below the Michigan Central Railroad Bridge, the depth being 18 feet and the material removed amounting to 1,430 cubic yards.

To complete the dredging in the inner harbor it is estimated that $5,000 will be required, and it is respectfully recommended that this amount be appropriated for the fiscal year ending June 30, 1889.

Small appropriations will probably be required from time to time to keep the channel clear.

Original estimated cost of work, 1870, amended 1878	$100,000.00
Whole amount appropriated 1878 to 1887, inclusive	96,875.00
Whole amount expended	94,070.59

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Money statement.

July 1, 1886, amount available		$2,299.17
Amount appropriated by act approved August 5, 1886		1,875.00
		4,174.17
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$842.34	
July 1, 1887, outstanding liabilities	38.58	
		880.92
July 1, 1887, amount available		3,293.25
Amount (estimated) required for completion of existing project		3,125.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids received and opened September 8, 1886, by Capt. D. W. Lockwood, Corps of Engineers, for furnishing material, harbor at Michigan City, Ind.

No.	Name and address of bidders.	White pine timber, 12 by 12 inches.		Pine plank, 3 by 10 inches by 16 feet.		Pine plank, 2 by 12 inches by 14 feet.		Oak timber, 10 by 12 inches.	
		Per M feet.	Total.	Per M feet.	Total.	Per M feet.	Total.	Per M feet.	Total.
1	Henry L. Green, Chicago Ill.								
2	J. M. Allmendinger, Benton Harbor, Mich							$28.00	$313.16
3	Albert H. Petrie, Muskegon, Mich	$17.95	$3,582.96	$12.95	$734.52	$12.95	$734.52	31.95	858.48
4	Excelsior Stone Company, Chicago, Ill								
5	S. D. Kimbark, Chicago, Ill								
6	Kelley, Maus & Co., Chicago, Ill								
7	Leathern & Smith, Sturgeon Bay, Wis			$12.00	600.00		(*)		
8	Chicago and Lemont Stone Company, Chicago, Ill								

No.	Name and address of bidders.	Piles, Norway, 38 feet long.		Drift-bolts.		Screw-bolts complete.		Spike.	
		Per linear foot.	Total.	Per pound	Total.	Per pound	Total.	Per pound	Total.
		Cents.		*Cents*		*Cents.*			
1	Henry L. Green, Chicago, Ill.			2.1	$194.50	2.6	$399.83		
2	J. M. Allmendinger, Benton Harbor, Mich								
3	Albert H. Petrie, Muskegon, Mich.	19½	$4,446.00						
4	Excelsior Stone Company, Chicago, Ill								
5	S. D. Kimbark, Chicago, Ill			2.2	203.76	2.65	407.52	2.4	55.20
6	Kelley, Maus & Co., Chicago, Ill			2.25	208.39	2.85	438.27	2.53	58.65
7	Leathern & Smith, Sturgeon Bay, Wis.	14	3,192.00						
8	Chicago and Lemont Stone Company, Chicago, Ill								

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Abstract of bids received and opened September 8, 1886, etc.—Continued.

No.	Name and address of bidders.	Nails.		Stone on scows at Chicago.		Stone at Michigan City.	
		Per pound	Total.	Per cord.	Total.	Per cord.	Total.
		Cents.					
1	Henry L. Green, Chicago, Ill	2.1	$21.63	.....	.....	.....	.....
2	J. M. Allmendinger, Benton Harbor, Mich	.....	.....	.....	.....	.....	.....
3	Albert H. Petrie, Muskegon, Mich	.....	.....	.....	.....	.....	.....
4	Excelsior Stone Company, Chicago, Ill	.....	.....	$5.59	$4,158.96	$9.35	$6,948.40
5	S. D. Kimbark, Chicago, Ill	2.15	26.26	.....	.....	.....	.....
6	Kelley, Maus & Co., Chicago, Ill	2.05	21.11	.....	.....	.....	.....
7	Leathern & Smith, Sturgeon Bay, Wis	.....	.....	.....	.....	.....	.....
8	Chicago and Lemont Stone Company, Chicago, Ill	.....	.....	5.50	4,092.00	9.00	6,690.00

* No bid on 14-foot.

The following bids were accepted: J. M. Allmendinger's for oak timber; Albert H. Petrie's for pine timber and plank; S. D. Kimbark's for iron; Leathern & Smith's for piles; Chicago and Lemont Stone Company's for stone on board scows at Chicago.

Abstract of bid received and opened May 25, 1887, by Capt. D. W. Lockwood, Corps of Engineers, for services of tug at Michigan City, Ind.

Name and address of bidders.	Towing about the harbor and to and from the dumping ground.	Bringing stone from Chicago, Ill.
	Per hour.	*Per cord.*
A. D. Campbell, Michigan City, Ind.*	$4.00	$2.00

* Bid accepted.

COMMERCIAL STATISTICS, MICHIGAN CITY HARBOR, INDIANA, FROM JULY 1, 1886, TO JUNE 30, 1887.

Vessels entered and cleared	1,099
Tonnage	213,686

Articles entered and cleared.

Entered:		
Lumber	feet, B. M.	98,755,954
Lath	pieces	33,685,000
Shingles	do	90,188,000
Pickets	do	104,000
Posts	do	10,000
Pig-iron	tons	16,538
Salt	barrels	68,407
Stone	cords	625
Piles	pieces	600
Cleared:		
Hay	tons	500
Sand	cubic yards	7,000

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J J 16.

PRELIMINARY EXAMINATION OF GRAND RIVER, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 29, 1887.

SIR: In compliance with printed letter from Office Chief of Engineers, dated Washington, D. C., September 27, 1886, I have the honor to make the following report with reference to the preliminary examination of Grand River, Michigan, called for in said letter.

In 1880 a survey of the river between Grand Rapids and Grand Haven was made under the direction of the late Major Harwood, Corps of Engineers.

The field-work was commenced early in September and completed in December.

Upon this survey was based Major Howard's project for obtaining a low-water channel 100 feet wide and 4 feet deep, at an estimated cost of $25,000.

The first appropriation for carrying out this project was made by act approved March 3, 1881—$10,000. By act approved August 2, 1882, an additional appropriation of $15,000 was made. The amount available from these appropriations July 1, 1884, was $386.04. At this time the river had been deepened to 4 feet, above the Lake Shore and Michigan Southern Railway Bridge, or for a distance of 2½ miles. By act approved July 5, 1884, an additional appropriation of $25,000 was made.

Before submitting a project for the expenditure of this amount authority was asked to make a special survey to cover the localities embracing the shoals. This survey extended from the foot of Ganoe's Canal to a point 11¼ miles down-stream, and was necessarily continuous on account of the number of the shoals and their nearness to each other. The survey showed that for this portion of the river the lengths of the cut to secure depths of 4.5 feet, 5.5 feet, and 6.5 feet, would be 6.18 miles, 9.54 miles, and 10.57 miles, respectively, with several shoal places below the limit of the survey to be taken account of in securing the depth stated above. But little benefit was found to have resulted from the work done in previous years.

A contract was entered into March 20, 1885, with Robert Finch, of Grand Haven, to dredge a cut 60 feet wide and 4.5 feet deep, commencing near the upper limit of the survey and extending down-stream as far as funds would permit. Work was commenced May 13, 1885, and closed in July, 1886. This gave for the time a continuous channel 60 feet wide and 4.5 feet deep from the foot of Ganoe's Canal to the foot of Hare's Bar, a distance of 11¼ miles.

The greater part of the material removed was sand, and I can see no reason for anticipating any thing like permanency for the channel, as the main causes that were in operation to maintain the river at its normal depth before work commenced are active now to restore its bed to its former condition. One small steamer with a maximum draught of 30 inches makes three round trips per week between Grand Rapids and Grand Haven during the season of navigation.

I have stated the above facts to show that no further examination of the river is necessary with a view to its improvement by dredging, and in considering any other plan for improving the river itself it is necessary to take account of other facts.

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The stage of water sometimes reaches 16 feet, and at very low water in the summer the discharge is so small that there is a notable difference between the morning and evening gauge-readings due to the quantity of water taken from the river by the various factories, mills, etc., along its banks.

In my opinion deep-water connection with Lake Michigan can only be secured by canal, outside of the river banks, using the river as a feeder. To determine the feasibility of such a plan and arrive at any thing like a correct estimate of its cost will require an extensive detailed survey covering not only both banks of the stream but in all probability other lines with a view to selecting the most suitable.

I do not consider the river itself worthy of improvement.

The freight receipts during the past year are reported by the firm owning the steamer already mentioned to have been $12,325.58. The commercial statistics of Grand Rapids were given by Major Harwood in his original report on the river. (Report of Chief of Engineers, 1881, page 2225.)

Grand River, below Grand Rapids, is situated within the limits of the Michigan collection district of Michigan. The nearest port of entry is Grand Haven, at the mouth of the river, where also is the nearest light-house.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

J J 17.

PRELIMINARY EXAMINATION OF PIGEON RIVER, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., August 25, 1887.

SIR: In compliance with printed letter, dated Office of the Chief of Engineers, United States Army, Washington, D. C., October 28, 1886, I have the honor to submit the following report of a preliminary examination of Pigeon River, Michigan, made by me July 6, 1887.

Pigeon River rises in the southern part of Huron County and empties into Saginaw Bay at a point about 23 miles southwest of Point Aux Barques. It has a sluggish current, and near its mouth is from 50 to 100 feet wide and from 4 to 6 feet deep. In the river and harbor act passed August 2, 1882, an examination of the harbor at Caseville, Mich., was provided for, and the late Maj. F. U. Farquhar, Corps of Engineers, in his report, dated October 21, 1882, and published in the Report of the Chief of Engineers for 1884, page 2077, stated that he did not regard the harbor as worthy of improvement by the General Government.

Caseville is located at the mouth of Pigeon River, and, as the stream itself is absolutely of no commercial importance, except for running logs and timber generally, it is presumed that the intention of the act of August 5, 1886, was to have an examination made of the mouth of Pigeon River with a view to determining whether there was any necessity for establishing a harbor there.

At the time of the first examination, in 1882, the mouth of the river had been extended into Saginaw Bay a distance of about 900 feet, by

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parallel piers 75 feet apart, and the depth of water between them was about 10 feet at the outer end of channel and 6 to 8 feet at the inner end. The 12-foot curve was stated to be 400 feet in advance of the end of piers, or one-fourth mile from shore.

At the time stated above the shipments from and to the port were as follows: 50,000 barrels of salt; 6,000,000 to 8,000,000 feet, B. M., lumber; 12,000 tons pig metal; 50,000 bushels of wheat, and about $200,000 worth of general produce, shipped out by water each season; 20,000 tons iron ore, 1,500 cords of limestone, and about $200,000 worth of merchandise shipped in by water each season.

At the time I made an examination the south pier was a total wreck, and the north pier fast becoming so, the old channel had shoaled up so as to be practically useless except for vessels of very light draught, and shipments by water had virtually ceased. The iron furnace has been shut down for several years, and one saw-mill and one salt-block only were in operation at the time, the latter with a capacity of 4,000 barrels per month. There is little or no lake commerce at this point at present, shipments and receipts being for the most part by rail.

Caseville is a village of about 600 inhabitants and is the northern terminus of the Pontiac, Oxford and Port Austin Railroad. The closing down of the iron furnace and the death of Mr. Crawford, who owned large interests in the locality and who constructed the old harbor, have caused its present decline.

Any work of improvement at this point would be for the benefit of local commerce only. I do not regard this harbor as worthy of improvement by the General Government, as there exists no public necessity for the same.

Pigeon River is located in the collection district of Huron, Mich. The nearest lighthouse is at Charity Island. The nearest port of entry is Port Huron, Mich.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J J 18.

PRELIMINARY EXAMINATION OF CARP RIVER, MICHIGAN, AT LELAND, WITH A VIEW TO AFFORDING AN ENTRANCE TO CARP LAKE FOR HARBOR OF REFUGE.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., October, 1887.

SIR: In compliance with instructions contained in printed letter dated Office of the Chief of Engineers, United States Army, Washington, D. C., October 28, 1886, I have the honor to submit the following report of the preliminary examination of "Carp River at Leland, Mich., with a view to affording an entrance to Carp Lake for harbor of refuge."

Leland is a town of about 400 inhabitants, although this number varies very materially from time to time. It owed its former importance to the traffic in wood with passing steam vessels, and to an iron furnance that was at one time operated here, but which has been shut down for a number of years. At present its commerce has dwindled to almost nothing, and its present appearance is that of a town that has been going backwards for years.

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In the Report of the Chief of Engineers for 1870, page 148, will be found a report by Capt. F. U. Farquhar, Corps of Engineers, in which the various points bearing on the question of a harbor in this locality are fully discussed. The following extracts are taken from it:

The Carp River, about three-fourths of a mile long, is the outlet of Carp Lake. Between Carp Lake and Lake Michigan there is a difference of level of about 8 feet.

As to the practicability of improving the harbor of Leland:

The Carp River is so inconsiderable a stream as to preclude any use of it for navigable purposes. As rock is said to be found near the surface, any deepening or widening of the stream itself and carrying out piers into the lake to protect its mouth would be enormously expensive, and after such expenditure the outflow would not be sufficient to keep a useful channel into the lake.

As to the necessity for improving the harbor of Leland:

The only necessity that exists for the proposed improvement is the mere local commerce of the place.

Which, as already stated, now amounts to little or nothing.

Although the route of the general commerce of the lake passes within 12 miles of this place, there is no necessity for a harbor of refuge here. Ample natural harbors of refuge are afforded by the Manitou Islands and Grand Traverse Bay.

I fully agree with the foregoing opinions and conclusions.

It is 16½ miles from Leland to Cat Head Light, on the west cape of Grand Traverse Bay, 10½ miles to the North Manitou, and 15½ miles to the South Manitou. The islands mentioned and Grand Traverse Bay have been used for shelter and refuge since Lake Michigan was first navigated.

As the examination was required to be made with a view to determining the practicability of affording an entrance to Carp Lake "for harbor of refuge," there are other considerations to be taken into account.

1st. If the channel between the two lakes should be a level cut, the effect of lowering the level of Carp Lake 8 feet should be examined into. In my opinion the results would be of such a character as to preclude the adoption of this plan.

2d. The only other method available would be by lockage, and as this would seriously interfere with free access to the anchorage in Carp Lake, it could not be adopted.

For the reasons given I do not regard this locality as worthy of improvement.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. ARMY.

J J 19.

PRELIMINARY EXAMINATION OF LAKE MICHIGAN AT EMPIRE, WITH A VIEW TO CUTTING A CHANNEL ACROSS THE BAR FROM LAKE MICHIGAN TO BAR LAKE.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., August 26, 1887.

SIR: In compliance with instructions contained in printed letter, dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., October 28, 1886, I have the honor to submit the following report of the pre-

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liminary examination of "Lake Michigan at Empire, with a view to cutting a channel across the bar from Lake Michigan to Bar Lake, Michigan."

In the river and harbor act approved June 14, 1880, an examination was directed to be made of Empire Bay, Leland County, Michigan. The late Major Harwood, Corps of Engineers, was charged with this duty, and his report was published in the Report of the Chief of Engineers, U. S. Army, for 1881, page 2258. There are two Bar Lakes in the vicinity of Empire, called, respectively, North and South Bar Lakes, distant from each other a little more than one-half of a mile. The water-surface of North Bar Lake is 2 feet above that of Lake Michigan, while that of South Bar Lake is 2½ feet above the same level. The hamlet of Empire is located at the south end of South Bar Lake, and consists of a steam saw-mill, with dock built out into Lake Michigan, a general store, and a few homesteads. The population is only that needed to operate the mill and supply it with logs. As this is the only settlement in the locality, it would seem that the connection with Lake Michigan, if made at all, should be made near it. The deepest soundings in South Bar Lake show only 13 feet, and with the water-surface at the level of that in Lake Michigan the area comprising 10 feet soundings would be about 2½ acres in extent, oval in shape, with its longer axis parallel to the shore-line of Lake Michigan. Should a channel be cut between North Bar Lake and Lake Michigan, the reduction in depth would leave an area about 700 feet long, parallel to the shore-line of Lake Michigan, and about 200 feet wide, with a least depth of 15 feet. This work would, however, be of no use to the present settlement at Empire.

Major Harwood estimated that it would cost $56,000 to connect North Bar Lake with Lake Michigan by a channel 200 feet wide and 15 feet deep, and $34,500 to do the same at South Bar Lake, limiting the depth to 10 feet. I should say that at this date these figures should be doubled.

The connection of either lake with Lake Michigan would be of purely local importance, and I do not regard this locality as worthy of improvement.

The principal interests at Empire are owned by Messrs. Potter & Strothers. The latter informed me at the time of the examination (August 8, 1887), that their shipments for the current year would be about 1,000,000 feet, board measure, lumber; between 400 and 500 cords of wood, and the same of bark, but that they expected to double their shipment of lumber next year.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

J J 20.

PRELIMINARY EXAMINATION OF GRAND TRAVERSE BAY, WITH A VIEW TO CONNECTING IT WITH TORCH LAKE NEAR EASTPORT, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., October 13, 1887.

SIR: In compliance with instructions contained in printed letter dated Office of the Chief of Engineers, U. S. Army, Washington, D. C., October 28, 1886, I have the honor to submit the following report of preliminary examination of "Grand Traverse Bay, with a view to connecting it with Torch Lake near Eastport, Michigan."

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Torch Lake is 17½ miles long and from ⅜ to 2½ miles wide; its general direction is nearly parallel to the east shore of Grand Traverse Bay, with which it is connected at its southern extremity through a series of lakes and short streams. At the time of the examination the difference of level between the waters of Grand Traverse Bay and Torch Lake was found to be 7 feet. The water-level in Lake Michigan at the time was 1.1 feet above zero, while that in Torch Lake was undoubtedly low on account of continued dry weather, so that the normal difference of level may be taken at about 8 feet. Should a connection between the two bodies of water be made, the location of the cut would be somewhere between Eastport and a point a little south of the town of Torch Lake. At the latter place a tramway has been constructed across the neck of land separating the bay from the lake, and here a line of levels was run for determining the difference of level between the two bodies of water and the height of the intervening land. The highest point of the latter was found to be 37.4 feet above the water-surface of Grand Traverse Bay, and the distance across about three-fourths of a mile from shore-line to shore-line.

The definite location of a canal in this locality could, as a matter of course, only be determined after a careful and systematic survey of the region between the limits given above, taking into account the harbor facilities at the two extremities, particularly in Traverse Bay. The reason for making the examination at Torch Lake was that there was a cleared line there.

To the east of Torch Lake, and connected with it, there is a net-work of small lakes and streams particularly favorable for getting out timber products, which consist of hard-wood timber, cord-wood, cedar posts, and railroad ties.

At the town of Torch Lake, as already stated, there is a tramway from Torch Lake to Traverse Bay. The Messrs. Cameron, who own it, have a mill at the Torch Lake end and a bridge pier in Grand Traverse Bay, from which vessels are loaded with the products of their mill. The senior member of the firm informed me that their shipments this year would be the equivalent of 12,000,000 feet of lumber.

According to the only estimate I have received, there are 500,000 cords of wood and 100,000,000 feet, board measure, hard-wood timber to be shipped from this region, and it is estimated that the value of the former would be increased 50 cents per cord and the latter 50 cents per thousand if better facilities for shipping, such as would be afforded by a canal, in fact, could be obtained.

There can be no question but that a connection between Traverse Bay and Torch Lake would be of great benefit to the country about and back of Torch Lake, but its benefits would be purely local, and the cost of a canal with lock would be great. It is known that part of the heavy cutting would be through rock of some kind, so that without further knowledge than can be obtained from an examination of the surface of the ground it is impossible to give an estimate of the cost of a canal; besides, the prolongation of the channel into Traverse Bay would have to be protected by piers, constituting a regular harbor.

In view of the foregoing, I feel compelled to state that I do not consider the locality worthy of improvement.

Very respectfully, your obedient servant,

D. W. LOCKWOOD,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX K K.

IMPROVEMENT OF ST. MARY'S RIVER—ENLARGEMENT OF AND OPERATING ST. MARY'S FALLS CANAL—CONSTRUCTION OF HARBOR OF REFUGE ON LAKE HURON, AND IMPROVEMENT OF CERTAIN HARBORS ON LAKE HURON AND OF SAGINAW RIVER—PRESERVATION OF AND OPERATING ST. CLAIR FLATS CANAL—IMPROVEMENT OF DETROIT RIVER.

REPORT OF LIEUTENANT-COLONEL O. M. POE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. St. Mary's Falls Canal and River, Michigan.
2. Operating and care of St. Mary's Falls Canal, Michigan.
3. Dry-dock at St. Mary's Falls Canal, Michigan.
4. Hay Lake Channel, St. Mary's River, Michigan.
5. Harbor at Sheboygan, Michigan.
6. Harbor at Thunder Bay, Michigan.
7. Harbor at Au Sable, Michigan.
8. Saginaw River, Michigan.
9. Harbor of refuge at Sand Beach, Lake Huron, Michigan.
10. Steam-launch or tug for harbor of refuge at Sand Beach, Lake Huron, Michigan.
11. Ice-harbor of refuge at Belle River, Michigan.
12. St. Clair Flats Canal, Michigan.
13. Operating and care of St. Clair Flats Canal, Michigan.
14. Clinton River, Michigan.
15. Detroit River, Michigan.

EXAMINATIONS AND SURVEY.

16. Bar in St. Clair River, Michigan, opposite Saint Clair City.
17. North River, Michigan, between Essex and North Bridges.
18. Biddle's Point at Mackinac Harbor, Michigan, with a view to a breakwater.
19. Harbor at Forrestville, Lake Huron, Michigan.
20. Pinepog River, Michigan.
21. Rouge River, Michigan, at its junction with Detroit River, and up the river to bridge of St. Louis and Wabash Railroad.
22. Mouth of Black River, Saint Clair County, Michigan.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., August 2, 1887.

SIR: I have the honor to transmit herewith the annual reports relating to the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1887.

I am, general, very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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KK 1.

IMPROVEMENT OF ST. MARY'S FALLS CANAL AND RIVER, MICHIGAN.

This improvement, projected to obtain a 16-foot navigation between lakes Superior and Huron, has been completed accordingly, at a cost of $2,404,126.32, exclusive of the grant of 750,000 acres of land to the State of Michigan, from the proceeds of which the canal was originally built, and excluding all expenditures on account of Hay Lake Channel. (For details see page 1785, Annual Report of the Chief of Engineers for 1886.)

Previous to its completion the available depth had been but 12 feet, and as soon as the additional depth was obtained the size and draught of vessels was increased to correspond with an enormous increase in the amount of commerce, until it is now evident to all that a further enlargement of the facilities must be made as soon as possible.

The amount of freight passing the canal has increased from 1,567,741 tons during the season of 1881 (when the enlarged canal first became available), to 4,527,759 tons during the season of 1886; that is to say, has trebled during the five years.

This fact emphasizes the remark made in the two preceding annual reports that—

> Should this rate of increase continue, the present lockage system will be insufficient to pass the commerce long before it can be, in the usual course of appropriations for river and harbor improvements, enlarged to meet the greater demands upon it.

This rate of increase has been fully maintained to the close of the fiscal year 1886–'87, during which the business of the canal amounted to 4,388,691 tons register and 4,882,802 tons of freight, exceeding the business of the preceding fiscal year by 1,183,460 tons register and 1,271,131 tons freight, or an increase of 24 and 32 per cent., respectively.

The commerce passing the canal during the month of June, 1887, reached the enormous figure of 1,685 vessels, of 849,789 tons register, carrying 953,921 tons of freight, or greater by 141,082 tons register and 219,303 tons freight than had ever before passed the canal in any one month. The increase in freight tonnage during this one month over the greatest commerce of any other entire month amounted to more than the entire commerce of the canal for the first two years it was in operation.

On one day during June, 1887, the freight tonnage through St. Mary's Falls Canal amounted to 50,720 tons, and the daily average for the month amounted to 30,797 tons.

Our estimate of the ultimate capacity of the present lock is an average of one vessel for each fifteen minutes during the twenty-four hours, or 96 vessels per day. Already we have had 84 vessels in one day during June, 1887, and the daily average for the entire month was 56½ vessels, or an increase of 40.6 per cent., as compared with the average of 40 vessels per day during June, 1886.

The provisional statements made in preceding annual reports have thus been more than verified.

The total amount of registered tonnage passed through the canal since its first opening in 1855, thirty-two years ago, is 37,684,802 tons, of which nearly one-half has passed since the opening of the new lock in 1881, a period of only six years.

At pages 1786 and 1787 of the Annual Report of the Chief of Engineers for 1886, a comparison is made for the year 1885 between the com-

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merce of the Suez Canal and that of St. Mary's Falls Canal. Without repeating all the details, the following comparison for the year 1886 may be interesting, and is therefore given:

FOR THE SUEZ CANAL.

Number of registered vessels		3,096
Official net tonnage	tons..	5,767,656
Canal open	days..	365
Average number of vessels per day		8½
Average daily tonnage	tons..	15,802

FOR ST. MARY'S FALLS CANAL.

Number of registered vessels		7,118
Registered tonnage	tons..	4,219,397
Freight tonnage	do...	4,527,759
Canal open	days..	224
Average number of vessels per day		31.8
Average daily registed tonnage	tons..	18,837
Average daily freight tonnage	do...	20,213

The number of vessels passing the Suez Canal in 1886 was 524 less than in 1885; the number of vessels passing the St. Mary's Falls Canal in 1886 was 2,075 greater than in 1885.

The tonnage of the Suez Canal decreased 568,097 tons; the tonnage of St. Mary's Falls Canal increased 1,183,460 tons register; 1,271,131 tons freight.

The daily average of registered tonnage through St. Mary's Falls Canal was 3,035 tons greater than through the Suez.

The river and harbor act of August 5, 1886, having provided for beginning the work of enlarging the canal, and appropriated the sum of $250,000 for "continuing improvement by a new lock and approaches," thus giving the sanction of both the legislative and executive branches to the proposition, it is deemed unnecessary to further pursue the subject.

Following the passage of that act, a general project for the work of enlargement was submitted, based upon a navigation of 20 feet in depth. This included a new lock 800 feet long between gates, 100 feet wide throughout, with 21 feet of water on the miter-sills, and overcoming the difference of level with a single lift (approximately 18 feet), to be located upon the site occupied by the combined locks in the original construction of the canal, with the requisite deepening of the canal prism.

This was approved by the War Department, and rendered practicable definite estimates of cost instead of the provisional estimates previously used. Under date of December 22, 1886, the estimates were submitted, and they were printed as House Ex. Doc. No. 72, Forty-ninth Congress, second session. For convenience of reference they are here repeated.

A project for the expenditure of the appropriation of August 5, 1886, was submitted under date of October 18, 1886. It has in view the construction of a coffer-dam 1,500 feet long and 300 feet wide to inclose the site of the new lock, the estimated cost being $195,392. This was duly approved by the Chief of Engineers, and by public advertisement proposals were invited:

(1) For furnishing one dredge, one tug, and two dump-scows, by the hour.

(2) For furnishing lumber.

(3) For furnishing iron drift-bolts and spikes.

(4) For framing, placing, filling, and completing crib-piers.

(5) For furnishing and placing puddling clay.

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The proposals received were opened December 13, 1886, resulting in contracts dated December 22, 1886, with Hickler & Green for item 1; with Chauncey E. Mitchell for item 2; with Ducharme, Fletcher & Co. for item 3; with Chauncey E. Mitchell for item 4, and with Carkin, Stickney & Cram for item 5.

Operations were begun May 4, 1887, under the contract with Hickler & Green, and 15,700 cubic yards of material had been removed at the close of the fiscal year; Ducharme, Fletcher & Co. have completed their contract, and operations will soon begin under the contracts of Chauncey E. Mitchell.

Soon after dredging began under the Hickler & Green contract it became evident that the dredging must be pushed with all the energy possible, and they were instructed to work day and night, which they have since continued to do. It was further apparent that additional dredging plant would be necessary, and in consequence proposals for a dredge, tug, and two dump-scows were invited. These were opened June 17, 1887, and the contract awarded to Carkin, Stickney & Cram, the articles of agreement with them being dated June 24, 1887. Nothing has yet been done under this contract.

Meanwhile, a drill-scow belonging to the United States has been employed, whenever practicable, in drilling and blasting in the bottom of the canal west of the movable dam, the operations being carried to the new canal-bottom.

A survey has been made of the water-front of Fort Brady military reservation, with a view to the construction of a pier throughout its whole length, the additional facilities being required as soon as means are available. With the present extent of pier below the locks vessels are necessarily crowded almost into the very jaws of the locks, and relief must be had as soon as practicable.

It is probable that the present available funds will suffice to construct the coffer-dam. They certainly will do so unless some unforeseen difficulties should be developed as the work progresses. Consequently the next appropriation can be devoted to the excavation of the lock-pit, building culverts, and lock-floor, etc., depending upon its amount. The larger the appropriation the more work can be put under contract, and the more rapidly it can be pushed forward. The estimate for excavating the lock pit and for the culverts and lock-floor (with its proportion of the estimate for contingencies) amounts to $1,010,875, and at least this sum should be appropriated for this purpose for the fiscal year 1888-'89, because, the excavation once made, the work should be carried forward without interruption to the extent indicated. Any other course will be unwise, and in case the coffer-dam should fail it might prove disastrous. And this sum should be made available at the earliest possible date. If postponed to about the 1st of August, as is usual at the long sessions of Congress, it will practically result in deferring operations to the opening of the season of 1889.

The estimate for the masonry of lock-walls is $980,000, which, with its proportion for contingencies, amounts to $1,225,000. This should be put under contract, in order that the stone may be quarried and worked long enough to properly season before being built into the wall.

The aggregate, then, of the funds which should be made available as soon as practicable is $2,235,875. Whilst any reduction of this amount would be a cause of great regret, yet, if it should be deemed necessary to make a reduction, the best way to do so would be to omit the $1,225,000 for masonry of lock-walls. On no account should the remainder ($1,010,875) be reduced, nor should the appropriation in that case

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be trammeled with any condition requiring more than the excavation of the lock-pit and building the culverts and lock-floor.

Amount (estimated) required for the enlargement of Saint Mary's Falls Canal, as projected in the foregoing report	$4,738,865
Amount that can be profitably expended during the fiscal year ending June 30, 1889	2,235,875

A comparative statement of the amount and value of the commerce through Saint Mary's Falls Canal for the calendar years 1885 and 1886, together with a statement of the commerce for each calendar year from the first opening of the canal, in 1855, to the end of 1886 are printed as House Ex. Doc. No. 116, Forty-ninth Congress, second session, a copy of which is hereto attached.

WATER-LEVEL OBSERVATIONS.

Water-gauge readings above and below the locks at Saint Mary's Falls Canal have been made daily. The monthly means of the readings taken above the locks have been deduced and platted in the usual way.

The mean monthly elevation of the surface of Lake Superior above sea level was as follows:

1886—June	601.46	1886—December	601.19
July	601.65	1887—January	600.94
August	601.80	February	600.84
September	601.63	March	600.77
October	601.61	April	600.64
November	601.60	May	601.00

The mean annual curve has been again deduced, using all the observations up to the present, and is as follows:

Mean of all the Januarys	601.23	Mean of all the Julys	601.97
Mean of all the Februarys	601.08	Mean of all the Augusts	602.06
Mean of all the Marches	600.99	Mean of all the Septembers	602.03
Mean of all the Aprils	600.96	Mean of all the Octobers	601.99
Mean of all the Mays	601.30	Mean of all the Novembers	601.85
Mean of all the Junes	601.71	Mean of all the Decembers	601.55

These means are somewhat lower than the preceding ones used on the plat, differing most in August, September, and October. The maximum difference being one-tenth of a foot in September.

A compilation of the foregoing data is shown on the accompanying tracing.

Money statement.

Received from sale of fuel		$26.63
Amount appropriated by act approved August 5, 1886		250,000.00
		250,026.63
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$14,743.45	
July 1, 1887, outstanding liabilities	7,373.76	
		22,117.21
July 1, 1887, amount available		227,909.42

Amount (estimated) required for completion of existing project.....4,738,865.00
Amount that can be profitably expended in fiscal year ending June 30, 1889.....2,235,875.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids for improving St. Mary's River and St. Mary's Falls Canal, Michigan, received and opened on December 13, 1886, in accordance with advertisement dated November 13, 1886.

No.	Names and addresses of bidders.	For furnishing one dredge, one tug, and two dump-scows; price per hour.
*1	Hickler & Green, Sault Ste. Marie, Mich.	Dredge No. 4, $9.08 Dredge No. 5, 10.00 Dredge No. 6, 11.00
2	Carkin, Stickney & Cram, East Saginaw, Mich.	11.50
3	Charles S. Barker, Duluth, Minn.	15.00

No.	Names and addresses of bidders.	Lumber for bulkhead, piers, and coffer-dam.				
		Lot 1, 676,488 feet B. M.; price per M feet, B. M.	Lot 2, 1,817,056 feet B. M.; price per M feet, B. M.	Lot 3, 130,700 feet B. M.; price per M feet, B. M.	Lot 4, 88,000 feet B. M.; price per M feet, B. M.	Approximate total.
*1	Chauncey E. Mitchell, Ludington, Mich.	$17.00	$13.25	$16.00	$16.00	$38,547.48
2	Carkin, Stickney & Cram, East Saginaw, Mich.	22.00	17.50	20.00	16.00	50,743.21
3	John W. McGinn, Cheboygan, Mich.	25.00	18.00	20.00	14.00	53,465.20
4	John G. Owen, East Saginaw, Mich.	30.00	20.00	24.00	16.00	61,180.56
5	Charles S. Barker, Duluth, Minn.	24.00	24.00	20.00	20.00	64,219.05

No.	Names and addresses of bidders.	Iron bolts and spikes.		
		Lot 1, blunt bolts, 174,000 pounds; price per pound.	Lot 2, boat spikes, 14,000 pounds; price per pound.	Approximate total.
		Cents.	*Cents.*	
*1	Ducharme, Fletcher & Co., Detroit, Mich.	2.60	2.70	$4,902.00
2	Mark Packard, Buffalo, N. Y.	2.79	2.6	5,211.60
3	Luther E. Allen, Charlevoix, Mich.	2.80	5.25	5,607.00
4	Hickler & Green, Sault Ste. Marie, Mich.	3.25	4.25	6,250.00
5	Charles S. Barker, Duluth, Minn.	3.5	3.5	6,580.00
6	Carkin, Stickney & Cram, East Saginaw, Mich.	3.5	4.5	6,720.00
7	Morley Brothers, East Saginaw, Mich.	4	3.20	7,408.00
†8	Chicago Forge and Bolt Company, Chicago, Ill.	2.75	.....	.....

* Recommended for acceptance. † Incomplete and informal.

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Abstract for bids for improving St. Mary's River, etc.—Continued.

No.	Names and addresses of bidders.	Framing, placing, and filling crib-piers.			
		Framing and placing white pine timber and plank, 45,000 cubic feet; price per cubic foot.	Framing and placing hemlock and Norway pine timber and plank, 1'5,000 cubic feet; price per cubic foot.	Filling cribs with stone, 25,000 cubic yards; price per cubic yard.	Approximate total.
		Cents.	*Cents.*	*Cents.*	
*1	Chauncey E. Mitchell, Ludington, Mich	6	6.50	37	$20,725.00
2	Carkin, Stickney & Cram, East Saginaw, Mich	6.50	6.50	50	24,200.00
3	Dumond & Lipsitt, Sault Ste. Marie, Mich	8	8.50	40	25,075.00
4	Augustus J. Dupins, Detroit, Mich	7.50	7.50	52	26,500.00
5	Hickler & Green, Sault Ste. Marie, Mich	7.75	7.75	60	28,950.00
6	Schwarz & Berner, Green Bay, Wis	8	8	63	30,150.00
7	Charles S. Barker, Duluth, Minn	8	8	65	30,650.00
8	Lorenzo D. Jenne, Sault Ste. Marie, Mich	9	9	70	33,700.00
9	Luther E. Allen, Charlevoix, Mich	10.8	10.8	91.25	42,252.50

No.	Names and addresses of bidders.	Furnishing and placing puddling clay for a coffer-dam.		
		Clay as is deposited in the dredge cut or trench, 20,000 cubic yards; price per cubic yard.	Clay as is deposited between the piers of the coffer-dam, 13,000 cubic yards; price per cubic yard.	Approximate total.
		Cents.	*Cents.*	
*1	Carkin, Stickney & Cram East Saginaw, Mich	56	56	$18,480.00
2	Hickler & Green, Sault Ste. Marie, Mich	65	70	22,100.00
3	Charles S. Barker, Duluth, Minn	80	80	26,400.00

* Recommended for acceptance.

Abstract of bids for furnishing one dredge, one tug, and two dump-scows, for use in improving St. Mary's River, Michigan, received and opened on June 17, 1887, in accordance with advertisement dated May 28, 1887.

No.	Name and address of bidder.	Price per hour.
1	Carkin, Stickney & Cram, East Saginaw, Mich*	$11.00

* Recommended for acceptance.

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In the following table is given a statement of the commerce through St. Mary's Falls Canal during the fiscal year ending June 30, 1887, together with a comparison between it and that of the preceding fiscal year:

Comparative statement of the commerce passing through St. Mary's Falls Canal during the fiscal years ending June 30, 1886, and June 30, 1887.

Items.	Quantity.		Increase.		Decrease.	
	1885-'86.	1886-'87.	Amount.	Per cent.	Amount.	Per cent.
Vessels.....number.	6,203	7,926	1,723	28	.....	.....
Lockages.....do..	3,232	3,692	460	14	.....	.....
Tonnage.....registered.	3,529,184	4,388,691	859,507	24	.....	.....
Do.....freight.	3,701,014	4,882,802	1,181,788	32	.....	.....
Passengers.....number.	34,356	28,848	.....	.....	5,508	16
Coal.....net tons.	922,158	1,173,544	251,386	27	.....	.....
Flour.....barrels.	1,696,263	1,543,443	.....	.....	152,820	9
Grain.....bushels.	17,346,212	22,637,376	5,291,164	30	.....	.....
Manufactured and pig iron.net tons.	73,691	116,324	32,633	44	.....	.....
Salt.....barrels	159,840	157,139	.....	.....	2,701	2
Copper.....net tons.	32,615	35,402	2,787	9	.....	.....
Iron ore.....do...	1,529,021	2,172,304	643,283	42	.....	.....
Lumber.....feet, B. M.	136,664,000	151,333,000	14,669,000	11	.....	.....
Silver ore.....net tons	3,434	1,129	.....	.....	2,305	70
Building stone.....do...	9,366	10,326	960	10	.....	.....
Unclassified freight.....do...	199,052	256,728	57,676	29	.....	.....

REVISED ESTIMATE OF THE PROBABLE COST OF IMPROVING ST. MARY'S RIVER, MICHIGAN, AND CONTINUING IMPROVEMENT BY MEANS OF A NEW LOCK AND APPROACHES.

UNITED STATES ENGINEER OFFICE.
Detroit, Mich., December 22, 1886.

SIR: The problem of "improving St. Mary's River, Michigan, continuing improvement by a new lock and approaches," has reached that stage when it is practicable to submit a better estimate of the probable cost than it has been possible to make prior to this time.

Certain general features of the project submitted for consideration with my letter of August 25, 1886, have already received the approval of the Chief of Engineers and the War Department, viz, the general dimensions of the proposed lock (800 feet between hollow quoins, 100 feet wide throughout, 21 feet of water on the miter-sills, and a single lift of 18 feet); the navigable depth of the canal prism (20 feet); the omission of middle gates, the number of filling culverts to be not less than four nor more than six.

Since submitting the project referred to, an accident of a character not anticipated has occurred to the lower gates of the lock of 1881 (see my letter of December 21, 1886), indicating the probability that it would be wise to reconsider the action adverse to the construction of a set of intermediate gates, with a view to reducing to a minimum the length of time that navigation would be interrupted in case of such injury to the lower gates as to require them to be rebuilt. If such an accident were to happen a set of intermediate gates, just above the lower gates, would serve a valuable purpose not heretofore considered, namely, to permit the use of the lock, somewhat shortened in the chamber, whilst the new gates were under construction. This matter is so important that I feel compelled to reconsider my former proposition, and to now

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recommend that a set of intermediate gates be provided for to be placed as near the lower gates as circumstances will permit, but not above the middle of the lock-chamber.

In making up the estimates I have avoided going into detail as regards dimensions and modes of construction, preferring to leave all questions relating to these matters in such form as to admit of complete flexibility.

For convenience in estimating the work has been divided into thirteen parts, as follows:

(1) Building coffer-dam.
(2) Excavating lock-pit.
(3) Building culverts and lock-floor.
(4) Building lock-walls.
(5) Constructing gates.
(6) Lock machinery and machine-house.
(7) Deepening canal to 21 feet.
(8) Remodeling movable dam.
(9) Building pier in front of Fort Brady Reservation, and extension of the northeast pier. (These form part of the approaches to the lock.)
(10) Earth filling.
(11) Building office and warehouse.
(12) Engineering and office expenses.
(13) Pumping lock-pit during construction.

(1) *For building the coffer-dam*, plans, estimates, and specifications were submitted by me, under date of October 18, 1886, and duly approved, the estimated cost being $195,392.88, the materials to be furnished by contract and the work done by the same mode.

(2) *Excavating the lock-pit.*—The estimate is made as follows: The amount to be excavated is very nearly twice as great as was required for the lock of 1881, the cost of which was $176,850. Since the character of material, cost of labor, facilities for dumping, etc., are practically the same in both cases, the total cost will be proportional to the amount. Therefore the estimated cost of excavating the lock-pit for the proposed lock is $353,700, or about $1.25 per cubic yard. This part of the work should be done by contract.

(3) *Building culverts and lock-floor.*—Since there are to be nearly five times as many linear feet of culverts in the proposed lock as in that of 1881, the cost is estimated at five times the cost of the present culverts, or $285,000, and since the floor and foundations in the proposed lock are twice as large as in that of 1881, the cost is estimated at twice that of the present floor and foundations, or $170,000, making together the sum of $455,000. This part of the work should be done by contract.

(4) *Masonry of the lock-walls.*—It is estimated that there will be 70,000 cubic yards of stone work. The cost per yard in the lock of 1881 was about $14 per cubic yard. The estimated cost of masonry in the proposed lock is therefore $980,000. The manner of doing this is left in abeyance.

(5) *The gates.*—The material of which the gates should be built has not yet been determined. If it should be decided to build them of iron there is nothing with which to compare them, and estimates can only be made after the material and plans have been settled upon. As an approximate estimate, however, sufficient probably to cover the cost whatever material be used, the sum of $250,000 may be named, and it is probable that the work should be done by contract, certainly in that manner in case iron be selected as the material.

(6) *Lock machinery, machine-house, etc.*—The cost of these need not materially exceed that of the lock of 1881, which was about $80,500, or say, for the new lock, $100,000.

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(7) *Deepening the canal.*—The approved project contemplates a 20 foot navigation. At present vessels pass drawing 15 feet of water. When the lock is being filled the lowering of the water in the canal occasionally causes them to touch bottom. This will be much more liable to occur when there are several more culverts in operation. There should then be at least 1 foot of water under the keel of a vessel drawing 20 feet. The extent of the deepening required is therefore 6 feet. The amount to be excavated for this depth between the upper end of the locks and the old coffer-dam is 150,000 cubic yards, and is all sandstone bed-rock, and the cost of excavation of this portion is estimated at $3 per cubic yard, or a total of $450,000.

The amount to be excavated above the old coffer-dam is estimated at 225,000 cubic yards. This portion is softer material, and the cost of its removal is estimated at 40 cents per cubic yard, or a total of $90,000.

The amount to be removed from below the locks is estimated at 64,000 cubic yards of bed-rock and bowlders, all of which must be excavated under water. The cost is estimated at $3 per cubic yard, or a total of $192,000.

The aggregate cost of excavation is consequently estimated at $450,000+$90,000+$192,000=$732,000 and the whole of it should be done by contract.

(8) *New movable dam.*—Since the length of the wickets will be 6 feet greater, the new dam should be about twice as strong as the present one, the cost of which was $95,500. The estimated cost of the new one is therefore $191,000.

(9) *Building pier in front of Fort Brady Reservation, and extension of the northeast pier.*—These constitute a part of the approaches to the locks. The former was contemplated when the water-front of the military reservation was set apart for canal purposes, and has been many times referred to within the last three years. It should be one of the earliest works undertaken. Its length will be about 1,200 feet, and its cost is estimated at $40,000. The northeast pier need not be built until some time has elapsed. Its length will be about 1,200 feet, and its cost is estimated at $50,000, or an aggregate of $90,000 for the two.

(10) *Earth filling.*—The amount of this that will be required is estimated at twice the quantity required for the lock of 1881, and its total cost at twice that in the latter case, or $44,000.

(11) *Building canal office and warehouse.*—These should be substantial, and include a fire-proof vault for the storage of the drawings, note-books, canal-books, and other valuable records, both during the progress of the work and after its completion. This vault should be built in the earlier stages of the work. The cost of the buildings is estimated at $75,000.

(12) *Engineering and office expenses.*—These are estimated at $300,000, upon the supposition that the work will be in progress for ten years.

(13) *Pumping lock-pit.*—The cost of this is estimated at $25,000, but it should be understood that this is the merest guesswork, as it is utterly impossible to predict what will be required and definitely estimate its cost.

Contingencies.—The contingencies in a work of the character of this one are so numerous and so uncertain that the ordinary estimate of 10 per cent. is not deemed sufficient, and in my opinion it is not safe to estimate them at less than 25 per cent., especially in view of the fact that the comparisons with former work depend upon the prices of material and labor at that time, and they may prove to be considerably greater in the new work.

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The estimate of the cost of this work, the largest of its kind in the world, may then be summarized as follows:

For coffer-dam	$195,392
For excavating lock-pit	353,700
For culverts and lock-floor	455,000
For masonry of lock-walls	980,000
For lock-gates	250,000
For lock machinery	100,000
For deepening the canal	732,000
For new movable dam	191,000
For building pier in front of Fort Brady Reservation and extending north-east pier	90,000
For earth filling	44,000
For building canal office, warehouse, fire-proof vault, etc.	75,000
For engineering and office expenses	300,000
For pumping lock-pit	25,000
For contingencies, 25 per cent	947,773
Total	4,738,865

There are still two items not estimated for in the foregoing, which are in the nature of contingencies. The first is referred to in my general project (see pages 16, 17, 18, and 19, of my letter of August 25, 1886), and relates to the possibility of a necessity for increasing the cross-section of the prism in order to furnish a sufficient water supply to the culverts without causing dangerous currents in the canal. The probability is that the railroad draw-bridge over the canal, authorized by the act of Congress approved July 8, 1882, will be built during next summer. Afterwards the increased water-way could only be obtained by excavating a channel under the land span of the draw-bridge.

The second would arise from the necessity for building a movable dam over this new channel.

The aggregate cost of these two items would be large, but, for the reason that the necessity for them has not been demonstrated, no attempt is made to estimate for them.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

COMMERCE ON ST. MARY'S FALLS CANAL.

REPORTS OF LIEUTENANT-COLONEL O. M. POE, CORPS OF ENGINEERS.

I.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 29, 1886.

SIR: I beg leave to invite special attention to the report of this date upon the commerce of St. Mary's Falls Canal, and to suggest the propriety of transmitting it to Congress, for use in connection with the question of an appropriation for continuing the enlargement of St. Mary's Falls Canal, as all the information relating to the commercial statistics in possession of this office is therein tabulated in the most compact form.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lt. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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II.

UNITED STATES ENGINEER OFFICE,
Detroit, December 29, 1886.

SIR: I have the honor to submit the following report upon the commerce passing St. Mary's Falls Canal during the season of 1886, just closed. Statistics for the season are necessarily those of the calendar year.

The canal was open to navigation 224 days, the first vessel having passed on the 25th of April and the last on the 4th of December, thus making the season 13 days longer than in 1885.

On the 15th of July 67 vessels were passed through the locks, this being the greatest number in any one day in the history of the canal.

The average number of vessels passing per day during the month of June was 40; during July, 41¾; and during August, 40⅜, or for the three months a daily average of 40⅜ vessels. The daily average freight tonnage for the same period was 23,371 tons.

The largest freight tonnage ever passed in one day was on the 28th of July, 1886, when 63 vessels, carrying 43,442 tons, were locked through.

From the following comparative statement (Table No. 1) it will be seen that the registered tonnage passing the canal during the season was 4,219,397 tons, and the freight tonnage 4,527,759 tons. The ratio of increase over the year 1885 was 39 per cent. in each case.

The increase in freight tonnage over that of 1885 was 1,271,131 tons, of which 67 per cent. was in the single item of iron ore, although there was an increase in every item of freight except silver ore.

The same table shows the approximate value of the freight. The same valuations are used as in the corresponding statement for 1885, which, for convenience of reference, is repeated. The aggregate for 1886 is $69,080,071.95, being an increase of 29 per cent. over the aggregate value of 1885.

For convenient reference Table No. 2 has been prepared, to show the business of the canal from the beginning, and constitutes a most interesting exhibit. The growth of the commerce of the Lake Superior region, and through it that of the great Northwest, is very readily traced, not only in quantity, but in the items composing the aggregate.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Lt. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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No. 1.—*Comparative statement of the amount and value of the commerce through St. Mary's Falls Canal, Michigan, for the calendar years* 1885 *and* 1886.

Items.	Quantity.		Increase.		Decrease.		Price per unit.	Total valuation.	
	1885.	1886.	Amount.	Per cent.	Amount.	Per cent.		1885.	1886.
Vessels.....number..	5,380	7,424	2,044	38					
Lockages.....do....	2,863	3,593	730	25					
Tonnage.....registered..	3,035,937	4,219,397	1,183,460	39					
Do.....freight..	3,256,628	4,527,759	1,271,131	39					
Passengers.....number..	36,147	27,088			9,059	25			
Coal.....net tons..	894,991	1,009,999	115,008	13			$3.50	$3,132,468.50	$3,534,996.50
Flour.....barrels..	1,440,093	1,759,365	319,272	22			5.00	7,200,465.00	8,796,825.00
Grain.....bushels..	15,697,194	19,706,858	4,009,654	26			.98	15,383,250.12	19,312,720.84
Manufactured iron.....net tons..	60,842	115,208	54,366	89			{ 50.00	2,576,750.00	5,366,950.00
Pig-iron.....do....							{ 17.00	158,219.00	133,773.00
Salt.....barrels..	136,355	158,677	22,322	16			1.00	136,355.00	158,677.00
Copper.....net tons..	31,927	38,627	6,700	21			200.00	6,385,400.00	7,725,400.00
Iron ore.....do....	1,235,122	2,087,809	852,687	69			3.50	4,322,927.00	7,307,331.50
Lumber.....feet, board measure..	127,984,000	138,688,000	10,704,000	8			18.00	2,303,712.00	2,496,384.00
Silver ore.....net tons..	3,669	2,009			1,660	45	153.79	564,255.51	308,964.11
Building stone.....do....	8,189	9,449	1,260	15			10.00	81,890.00	94,490.00
Unclassified freight.....do....	184,963	230,726	45,763	25			.60.00	11,097,780.00	13,843,560.00
Total.....								53,413,472.13	69,080,071.95

Canal was open to navigation 211 days in 1885.
Canal was open to navigation 224 days in 1886.

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No. 2.—*Statement of the commerce through St. Mary's Falls Canal for each calendar year from its opening in* 1855.

Year.	Sailing vessels.	Steamers.	Unregistered craft.	Total passages.	Total lockages.	Tonnage.		Passengers.	Coal.	Flour.	Wheat.	Grain, other than wheat.	Manufactured and pig iron.	Salt.	Copper.	Iron ore.	Lumber M ft., B. M.	Silver ore and bullion.	Building stone.	Date of opening.	Date of closing.
						Registered.	Actual freight.														
									Tons.	*Barrels.*	*Bushels.*	*Bushels.*	*Tons.*	*Bbls.*	*Tons.*	*Tons.*		*Tons*	*Tons*		
1855..	(a)	(a)	(b)	(a)	(c)	106,296	(d)	4,270	1,414	10,289	(e)	.....	1,040	587	3,196	1,447	126	(f)	(e)	June 18	Nov. 23
1856..	(a)	(a)	(b)	(a)	(c)	101,458	(d)	4,674	3,968	17,686	(e)	33,908	781	464	5,727	11,597	395	(f)	(e)	May 4	Nov. 28
1857..	(a)	(a)	(b)	(a)	(c)	180,820	(d)	6,650	5,278	16,560	(e)	22,300	1,325	1,500	5,760	26,184	572	(f)	(e)	May 9	Nov. 30
1858..	(a)	(a)	(b)	(a)	(c)	219,819	(d)	2,230	4,118	13,782	(e)	10,500	2,597	950	6,744	31,035	185	(f)	(e)	Apr. 18	Nov. 20
1859..	(a)	(a)	(b)	(a)	(c)	352,642	(d)	.....	8,884	39,459	(e)	71,738	5,504	2,737	7,727	65,769	.....	(f)	(e)	May 3	Nov. 28
1860..	(a)	(a)	(b)	(a)	(c)	403,657	(d)	.....	.....	50,250	(e)	133,437	.....	.....	9,000	120,000	.....	(f)	(e)	May 11	Nov. 26
1861..	(a)	(a)	(b)	(a)	(c)	276,639	(d)	8,816	11,507	22,743	(e)	76,830	4,194	3,014	7,645	44,836	394	(f)	(e)	May 3	Nov. 14
1862..	(a)	(a)	(b)	(a)	(c)	359,612	(d)	8,468	11,846	17,291	(e)	59,062	6,438	2,477	6,881	113,014	196	(f)	(e)	Apr. 27	Nov. 27
1863..	(a)	(a)	(b)	(a)	(c)	507,434	(d)	18,281	7,805	31,975	(e)	78,480	6,681	1,506	1,044	181,567	1,411	(f)	(e)	Apr. 28	Nov. 24
1864..	1,045	366	(b)	1,411	(c)	571,438	(d)	16,985	11,282	33,937	(e)	143,500	7,643	1,776	5,331	213,753	2,001	(f)	(e)	May 2	Dec. 4
1865..	602	395	(b)	997	(c)	409,062	(d)	19,777	.....	34,985	(e)	.....	7,346	3,175	9,935	147,459	822	(f)	(e)	May 1	Dec. 3
1866..	555	453	(b)	1,008	(c)	458,530	(d)	14,067	19,915	33,603	(e)	229,926	13,235	4,454	9,550	152,102	144	(f)	(e)	May 5	Dec. 3
1867..	839	466	(b)	1,305	(c)	556,899	(d)	15,120	22,927	28,345	(e)	249,031	20,602	5,316	10,585	222,861	390	(f)	(e)	May 4	Dec. 3
1868..	817	338	(b)	1,155	(c)	432,563	(d)	10,590	25,814	27,372	(e)	285,123	22,785	4,624	12,222	191,939	1,119	(f)	(e)	May 2	Dec. 3
1869..	939	399	(b)	1,338	(c)	524,885	(d)	17,657	27,850	32,007	(e)	323,501	23,851	5,910	18,662	239,368	1,260	(f)	(e)	May 4	Nov. 29
1870..	1,397	431	(b)	1,828	(c)	690,826	(d)	17,153	15,952	33,548	49,700	304,072	42,959	11,089	11,301	409,850	722	92	2,917	Apr. 29	Dec. 1
1871..	1,064	573	(b)	1,637	(c)	752,101	(d)	15,859	46,798	26,060	1,376,705	308,823	54,984	36,199	14,562	327,461	1,072	464	5,228	May 8	Nov. 29
1872..	1,212	792	(b)	2,004	(c)	914,735	(d)	25,830	80,815	136,411	567,134	445,774	86,194	42,690	14,591	383,105	1,744	306	5,213	May 11	Nov. 26
1873..	1,549	968	(b)	2,517	(c)	1,204,446	(d)	30,966	96,780	172,692	2,119,997	309,645	44,920	29,335	15,927	504,121	1,162	580	2,218	May 5	Nov. 18
1874..	833	901	(b)	1,734	(c)	1,070,857	(d)	22,958	61,123	179,855	1,120,015	149,999	31,741	42,231	15,846	427,658	638	443	401	May 12	Dec. 2
1875..	569	1,464	(b)	2,033	(c)	1,259,534	(d)	19,685	101,260	309,991	1,213,788	250,080	54,381	43,989	18,396	493,408	5,891	847	2,978	May 12	Dec. 2
1876..	684	1,733	(b)	2,417	(c)	1,541,676	(d)	30,286	124,734	315,224	1,971,549	407,772	64,091	46,666	25,756	609,752	17,761	985	2,102	May 8	Nov. 26
1877..	1,401	1,050	(b)	2,451	(c)	1,439,216	(d)	21,800	91,575	355,117	1,349,738	343,542	39,071	63,188	16,767	568,082	4,143	987	2,506	May 2	Nov. 30
1878..	1,001	1,476	(b)	2,567	(c)	1,667,136	(d)	20,394	91,356	344,599	1,872,940	264,674	14,882	63,520	22,529	555,750	24,119	650	2,754	Apr. 8	Dec. 3
1879..	1,408	1,618	100	3,121	(c)	1,677,071	(d)	18,979	110,704	451,000	2,603,666	951,496	39,218	92,245	22,309	540,075	35,598	824	2,226	May 2	Dec. 3
1880..	1,718	1,735	50	3,503	(c)	1,734,890	(d)	25,766	170,501	523,860	2,105,920	2,547,106	46,791	77,916	21,753	677,073	44,539	66	2,283	Apr. 28	Nov. 15
1881..	1,706	2,117	181	4,004	2,120	2,092,757	1,567,741	24,671	295,647	605,453	3,456,965	367,838	87,830	65,897	29,488	748,131	58,877	.....	1,400	May 7	Dec. 5
1882..	1,663	2,739	372	4,774	2,572	2,468,088	2,029,521	29,256	430,184	844,044	3,728,856	473,129	92,870	176,612	25,409	967,060	82,783	22	5,428	Apr. 21	Dec. 3
1883..	1,458	2,620	237	4,315	2,351	2,042,259	2,267,105	39,130	714,444	687,031	5,900,473	776,552	109,910	70,898	31,024	791,732	87,131	814	2,403	May 2	Dec. 11
1884..	1,709	3,609	371	5,689	3,074	2,997,837	2,874,557	54,214	706,879	1,248,243	11,985,791	517,108	72,428	144,804	36,062	1,136,071	122,389	9,731	6,047	Apr. 23	Dec. 10
1885..	1,689	2,354	337	5,380	2,963	3,035,927	3,256,628	36,147	894,991	1,440,093	15,274,213	422,981	60,842	136,355	31,927	1,235,132	127,984	3,669	8,189	May 6	Dec. 2
1886..	2,534	4,584	306	7,424	3,593	4,219,397	4,527,759	27,088	1,002,999	1,759,365	18,991,485	715,373	115,208	158,677	38,627	2,087,809	188,688	2,009	9,449	Apr. 25	Dec. 4

a No record kept until 1864.
b No record kept until 1879.
c No record was kept until the United States assumed control of canal in 1881.
d No record was kept until the United States assumed control of the canal in June, 1881.
e None shipped from Lake Superior until 1870.
f None shipped from Lake Superior until 1867.

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K K 2.

OPERATING AND CARE OF ST. MARY'S FALLS CANAL, MICHIGAN.

St. Mary's Falls Canal, about 1 mile in length, constitutes a part of the water-route between Lakes Huron and Superior, and affords a means of passing the Sault de Ste. Marie, overcoming by its lockage system a difference of level of about 18 feet.

The prism is of variable width, and has a depth of 16 feet at the ordinary stage of water.

The lockage system is double, at present consisting of two locks, built when the canal was first constructed, thirty-two years ago, and now known as the "Old Locks," and of a single lock by the side of the former, completed and opened to navigation September 1, 1881. The latter is known as the "New Lock."

The old locks are to be replaced by a single lock 800 feet long between gates, uniformly 100 feet wide, with 21 feet of water on the miter-sills, and having a lift of 18 feet, the full difference of level. It is therefore unnecessary to repeat the description given in the preceding reports of the old locks. Moreover, the coffer-dam inclosing the site of the projected lock will have reached such a stage within a month or two that the old locks will be no longer navigable. They were magnificent constructions in their day, and would still be useful if the commerce had not entirely outgrown them.

The new lock is 80 feet wide, narrowing to 60 feet at the gates, 515 feet between gates, and has a lift of 18 feet, with 17 feet of water on the miter-sills at the ordinary stage. It is an admirable structure, and splendidly serves its purpose. Its operation is rapid, quiet, and efficient, and the experience of the six years during which it has been in use proves the great care with which all the details of the construction were studied and the thoroughness with which they were wrought out.

ORGANIZATION.

The organization of the regular lock force remains the same as at the date of the last annual report, with but little change in the personnel. It consists of one superintendent, two assistant superintendents, one clerk, two enginemen, two foremen, four watchmen, and fifteen lockmen. These perform all the duties connected with passing vessels through the canal. The great increase in the traffic through the canal renders necessary an increase in the number of office watchmen.

A small labor party of variable strength is employed to make current repairs to buildings and piers and in policing the grounds, and in doing any other work that may be required of them.

ACCIDENTS AND DELAYS.

The work of passing vessels through the canal has been promptly and satisfactorily performed. The following accidents and delays have occurred during the fiscal year:

On August 9, 1886, a large fire occurred in the village. No canal property was burned, but the fences surrounding the canal grounds were broken down in many places by citizens who carried goods into the grounds for safety.

On October 15, 1886, the steam-barge *Smith Moore* ran into the lower lock-gate (from below), doing considerable damage. The injury was repaired in five hours, no vessels being delayed.

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On the 16th of the same month one of the gratings at the lower end of the lock was displaced so that the gate would not close. This was replaced by the diving crew, no delays occurring.

CARE OF GROUNDS AND PROPERTY.

During March and April the lock machinery was thoroughly overhauled and repaired in the usual manner. The works connected with the construction of the projected lock will soon require the removal of the present canal office. The old building on the south side of the canal, formerly occupied by the superintendent, has therefore been prepared for use as a canal office.

Small shade trees have been planted, the grass on the inclosed portions of the grounds kept cut, and the walks in good order.

MOVABLE DAM.

This important portion of the canal system has been regularly closed each month, both as a drill for the men, and to be sure that everything is in working order. This has usually been done at night after vessels have ceased to arrive. The movable dam and all its machinery have been kept in complete repair.

DIVING CREW.

The diving crew was employed two or three times a month in making the usual under-water repairs about the locks. During the month of August, 1886, it was employed almost constantly, in connection with the labor party, in picking up loose stones from the bottom of the canal. About 60 cubic yards were removed. All work required of the crew was done in a satisfactory manner.

SMALL HOUSE FOR LOCKMEN.

A small house has been built on the south side of the canal, near the upper gates of the lock, for a waiting-room for the lockmen and for a boiler-room.

ESTIMATES.

The estimated cost of operating and care during the fiscal year ending June 30, 1887, was $36,540. The actual cost was $21,988. The difference is due to the fact that after the estimate was made and approved the act of August 5, 1886, was passed appropriating $250,000 with which to begin the enlargement of the canal, and it was deemed wise to postpone the proposed extensive repairs to the canal piers until the progress of the enlargement should determine what portion of them were to remain. It was then proposed to expend a portion of the sum for timber for a set of lower gates for the new lock (of 1881), and contracts were made for its delivery on or before June 30, 1887, but the contractor failed to so deliver it, and has asked an extension of sixty days. Therefore the amount required for the purchase of this bill of timber is necessarily thrown into the fiscal year 1887–'88, although it really belongs to that for 1886–'87.

The project for operating and care of St. Mary's Falls Canal for the fiscal year ending June 30, 1888, contemplates maintaining the present organization, purchase of supplies, moving buildings rendered necessary by the work on the enlargement of the canal, building one set of lower gates for the new lock (of 1881), and such labor as may be necessary in making current repairs and policing the grounds.

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The estimated cost of the foregoing is as follows, viz:

For pay of regular lock force	$17,000
For pay of labor party	6,000
For general purchases	5,000
For building new set of lower gates	3,000
Total	31,000

The foregoing does not include the cost of the timber for the gates, nor is any estimate included for extraordinary repairs which may be rendered necessary by accident, since these cannot be foreseen, and therefore cannot be estimated for.

In case of injury or damage to the canal beyond that due to ordinary wear and tear, it must be promptly repaired at whatever cost, to avoid unnecessary delay to a commerce that has already outgrown all anticipation.

All expenses of operating and care are provided for by indefinite appropriation under section 4 river and harbor act approved July 5, 1884.

STATEMENT OF THE BUSINESS OF ST. MARY'S FALLS CANAL, MICHIGAN, FOR THE FISCAL YEAR ENDING JUNE 30, 1887.

Number and class of vessels passed:		
Side-wheel steamers		40
Screw steamers		4,860
Sail vessels		2,589
Rafts and unregistered craft		437
Total passages		7,926
Total registered tonnage		4,388,691
Total registered tonnage since opening the canal in 1855		37,684,802
Freight and passenger traffic:		
Coal	tons..	1,173,544
Copper	do...	35,402
Flour	barrels..	1,543,443
Wheat	bushels..	21,962,967
Grain (other than wheat)	do....	674,409
Iron ore	net tons..	2,172,304
Pig and manufactured iron	do....	116,324
Lumber	feet, B. M..	151,333,000
Salt	barrels..	157,139
Silver ore	tons..	1,129
Building stone	do...	10,326
Miscellaneous or unclassified freight	do...	256,728
Number of passengers		28,848

STATEMENT OF RECEIPTS AND EXPENDITURES AT SAINT MARY'S FALLS CANAL, MICHIGAN, DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Receipts:	
Dry docking	$452.00
Expenditures:	
Office expenses	779.09
General purchases	1,018.02
Repairs	1,964.56
Labor (operating canal)	16,919.55
Extra labor	1,287.25
Lights on locks	170.45
Total expenditures	22,138.92
Total receipts	452.00
Net cost of operating canal	21,686.92

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Statement of the number of vessels passed through the St. Mary's Falls Canal, Michigan, with number, time, and cost of lockages, for five fiscal years ending June 30, 1887.

Fiscal years.	Vessels.	Lockages.	Tonnage.		Time expended in receiving and passing vessels.		Time per vessel during which vessels were in the locks.	* Cost.			
			Registered.	Freight.	Per vessel.	Per lockage.		Per vessel.	Per lockage.	Per ton registered.	Per ton freight.
Through old locks:	*No.*	*No.*	*Tons.*	*Tons.*	*Min.*	*Min.*	*Min.*			*Cents.*	*Cents.*
1882–'83	218	165	.....	.....	31	40	34	.....	.....	.....	.....
1883–'84	179	138	.....	.....	37	48	38	.....	.....	.....	.....
1884–'85	93	67	.....	.....	29	47	43	.....	.....	.....	.....
1885–'86	18	11	.....	.....	37	61	51	.....	.....	.....	.....
1886–'87	12	9	.....	.....	45	61	57	.....	.....	.....	.....
Through new lock:											
1882–'83	2,950	2,165	.....	.....	19	35	34	.....	.....	.....	.....
1883–'84	4,589	2,431	.....	.....	20	37	33	.....	.....	.....	.....
1884–'85	5,536	2,964	.....	.....	19	36	31	.....	.....	.....	.....
1885–'86	6,185	3,221	.....	.....	19	37	34	.....	.....	.....	.....
1886–'87	7,914	3,683	.....	.....	19	41	34	.....	.....	.....	.....
Totals and means:											
1882–'83	4,163	2,330	2,130,181	1,874,404	20	37	34	$8.55	$15.42	1.67	1.89
1883–'84	4,768	2,569	2,333,257	2,540,799	21	35	33	5.90	10.95	1.21	1.11
1884–'85	5,621	3,031	2,981,786	2,870,728	19	36	31	4.69	8.75	.89	.92
1885–'86	6,203	3,232	3,529,184	3,701,014	19	37	34	4.01	7.71	.71	.67
1886–'87	7,926	3,692	4,388,691	4,882,802	19	41	34	2.72	5.83	.49	.44

* Cost includes all repairs and improvements made by the operating force and labor party, and all purchases therefor.

Comparing the foregoing statement with the corresponding one for 1885–'86, we find:

The number of passing vessels increased 1,723.
The number of lockages increased 460.
The registered tonnage increased 859,507 tons.
The freight tonnage increased 1,181,788 tons.
The cost of operating decreased per vessel $1.29.
The cost of operating decreased per lockage $1.88.
The cost of operating decreased per ton registered .22 of a cent.
The cost of operating decreased per ton freight .23 of a cent.

This showing of a reduction of nearly one-quarter of a cent per ton of freight in the cost of operating is somewhat misleading. It is due to two causes: first, deferred repairs; second, increase in freight tonnage. The amount required to pay the operating force and to furnish supplies must be taken the same for 500,000 tons of freight as for twenty times the amount; hence, assuming the annual charges as fixed, the cost for operating must diminish as the amount of tonnage increases.

During the fiscal year the canal was open to navigation 218 days, or four days less than during the fiscal year 1885–'86. It was closed for the winter December 4, 1886, and opened for the current season May 1, 1887.

On June 20, there were 84 passages through the canal, thus exceeding by 17 the greatest number in any previous season. It was not until the month of June, 1887, that the number of vessels passing in a day exceeded 67, and that number had only been reached in one day (July 15, 1886). The following is the showing for June, 1887:

	Days.
Over 80 vessels	1
Between 70 and 80 vessels	5
Between 60 and 70 vessels	5
Between 55 and 60 vessels	6

and the daily average for the whole month was $56\frac{1}{3}$ vessels. The daily average for the month of June, 1886, was $39\frac{13}{15}$ vessels, an increase of about 41 per cent.

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The statement of the business through the canal shows that the total registered tonnage for the fiscal year was 4,388,691 tons, and the total freight tonnage 4,882,802. For the registered tonnage this was 859,507 tons, and for the freight traffic 1,181,758 tons greater than for the fiscal year 1885-'86, which, up to that time, had been the largest in the history of the canal.

In addition to the lumber reported as passing through the canal during the fiscal year, 15,800,000 feet, B. M., of pine saw logs were run down the rapids. They were the property of numerous owners, and destined for manufacture at points below. The building of the railroad bridge across the canal and river, now in course of construction, is likely to interfere with this mode of transportation and throw additional burdens upon the canal. Should this prove to be the case to a considerable extent, it may become necessary to close the canal to rafts.

The total amount of registered tonnage passed through the canal since its first opening in 1855, up to June 30, 1887, a period of thirty-two years, was 37,684,802 tons, of which 17,732,315 tons, or nearly one-half, passed in the six years since the "new lock" was opened in 1881.

Money statement.

July 1, 1886, amount available		$36,540.00
Repayment of disallowance		4.66
		36,544.66
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$19,780.60	
July 1, 1887, outstanding liabilities	2,358.32	
		22,138.92
July 1, 1887, amount available by allotment for fiscal year ending June 30, 1888		31,000.00

Abstract of bids for supplies, etc., required for "Operating and care of St. Mary's Falls Canal, Michigan," received and opened on August 13, 1886, in accordance with advertisement dated July 29, 1886.

[No bidders for electric-light supplies.]

No.	Names and addresses of bidders.	Supplies.	Approximate total.	Machine work.
1	T. B. Rayl & Co., Detroit, Mich.*	Hardware	$149.24	
2	Jas. L. Fisher, Detroit, Mich	do	154.51	
1	Jas. E. Davis & Co., Detroit, Mich.*	Painters' supplies	367.46	
2	T. H. Hinchman & Co., Detroit, Mich	do	372.91	
3	Farrand, Williams & Co., Detroit, Mich	do	386.03	
4	Coffin, Devoe & Co., Chicago, Ill.†	do	316.82	
1	George W. Edwards, Detroit, Mich.*	Ship chandlery	203.60	
2	J. P. Donaldson & Co., Detroit, Mich	do	211.01	
1	George W. Edwards, Detroit, Mich.*	Leather and belting	249.78	
2	J. P. Donaldson & Co., Detroit, Mich	do	273.81	
3	Croul Bros., Detroit, Mich	do	283.00	
4	E. B. Preston & Co., Chicago, Ill.†	do	66.24	
1	H. W. Seymour, Sault Ste. Marie, Mich.*	Lumber	240.00	
2	E. D. Johnson, Sault Ste. Marie, Mich	do	250.00	
1	George Kemp, Sault Ste. Marie, Mich.*	Coal	140.20	
1	Hickler & Green, Sault Ste. Marie, Mich.*	Lathe-work, per hour		$0.60
	Do	Planer-work, do		.60
	Do	Steam-hammer work, do		.75
	Do	Bolt-cutter work, do		.60
	Do	Power-drill work, do		.60

*Recommended for acceptance. †Incomplete; no bid on kerosene oil.
‡Incomplete bid on first three items of leather withdrawn; no copy of letter attached to proposal.

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Abstract of bids for furnishing building material, electric-light supplies, and rubber valve-buffers for operating and care of St. Mary's Falls Canal, Michigan, received and opened on September 11, 1886, in accordance with advertisement dated August 27, 1886.

No.	Names and addresses of bidders.	Articles.	Amount.	Remarks.
1	E. D. Johnson, Sault Ste. Marie, Mich.	Building materials.....	$217.29	Recommended for acceptance.
1	Parker Russel Mining Co., Saint Louis, Mo.	Electric-light supplies..	159.50	Do.
2	William M. Porter, Detroit, Mich.	.....do	171.11	Incomplete; no bid on cable.
3	Western Electric Company, Chicago, Ill.	.....do	150.00	Incomplete; no bid on globes, brushes, and magnet spools.
4	E. S. Greeley & Co., New York, N. Y.	.....do	90.00	Incomplete; no bid on globes, brushes, magnet spools and cable.
1	George W. Edwards, Detroit, Mich.	Rubber valve-buffers ...	30.00	Recommended for acceptance.

Abstract of bids for furnishing timber and lumber for lock-gates at St. Mary's Falls Canal, Michigan, received and opened on February 11, 1887, in accordance with advertisement dated January 12, 1887.

No.	Names and addresses of bidders.	White oak, 43,721 feet, B. M., approximately, per M feet, B. M.	Norway pine, 8,438 feet, B. M., approximately, per M feet, B. M.	Approximate total.
*1	Westervelt & Dennis, Detroit, Mich.....	$54.50	$24.50	$2,589.52
2	Samuel Brady, agent, Detroit, Mich.....	57.50	40.00	2,851.47
3	C. J. Lloyd, Detroit, Mich.....	64.90	34.90	3,131.97

* No witnesses or guarantors. Informalities waived and recommended for acceptance.

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation as applied to operating and care of St. Mary's Falls Canal, Michigan, for the fiscal year ending June 30, 1887.

Date.	No. of voucher.	Object of expenditure.	Amount.
		Part of July.	
1886.			
June 30	4	T. Galvin, secretary and treasurer, repairing 10 valves of operating machinery, at 75 cents	$7.50
14	5	N. Eisenlord, secretary and treasurer, printing blank forms for receiving proposals.....	31.50
		August.	
Aug. 5	1-2	Pay-rolls, July:	
		1 superintendent, 1 month	150.00
		1 clerk, 1 month.....	150.00
		2 assistant superintendents, 2 months, at $100.....	200.00
		1 engineman, 1 month.....	90.00
		1 engineman, 1 month.....	80.00
		2 foremen, 2 months, at $75	150.00
		1 watchman, 1 month	50.00
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 1 month, 25 days, at $50.....	91.67
		11 lockmen, 11 months, at $45	495.00
		1 carpenter, 270 hours, at 25 cents.....	67.50
		1 scrubber, 50 hours, at 15 cents	7.50
		6 laborers, 1,517 hours, at 17½ cents	265.46

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	Object of expenditure.	Amount.
1886.		*September.*	
Sept. 3	1-2	Pay-rolls, August:	
		1 superintendent, 1 month	$150.00
		1 clerk, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 foremen, 2 months, at $75	150.00
		2 watchmen, 1 month and 28 days, at $50	96.67
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 1 month and 28½ days, at $60	117.00
		2 lockmen, 1 month and 19½ days, at $50	82.50
		11 lockmen, 10 months and 20 days, at $45	480.00
		2 divers, 17 days, at $10	170.00
		1 carpenter, 237½ hours, at 25 cents	59.37
		1 scrubber, 51 hours, at 15 cents	7.65
		6 laborers, 1,502½ hours, at 17½ cents	262.93
July 29	3	William E. Quinby, president, advertising for proposals for supplies	4.32
29	4	Charles R. Stuart, advertising for proposals for supplies	2.10
Sept. 30	5	George H. Smith, hire of 1 storage-room from July 1 to September 30, 1886 (both dates inclusive), 3 months, at $100 per year	25.00
		October.	
Oct. 6	1-2	Pay-rolls, September:	
		1 superintendent, 1 month	150.00
		1 clerk, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 foremen, 2 months, at $75	150.00
		2 watchmen, 1 month and 27 days, at $50	95.00
		2 watchmen, 1 month and 22 days, at $45	78.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 2 months, at $50	100.00
		11 lockmen, 10 months and 22½ days, at $45	483.75
		1 carpenter, 260 hours, at 25 cents	65.00
		1 scrubber, 40 hours, at 15 cents	6.00
		1 mason, 83⅔ hours, at 30 cents	25.10
		6 laborers, 1,482½ hours, at 17½ cents	259.43
		1 laborer, 10 hours, at 25 cents	2.50
1	3	H. W. Seymour, 18,114 feet, B. M. (common stock), pine lumber, at $12 per M	217.37
1	4	George Kemp:	
		18 tons (of 2,000 pounds) anthracite coal (stove size), at $5.65 per ton	101.70
		7 tons (of 2,000 pounds) anthracite coal, chestnut, at $5.50 per ton	38.50
1	5	Hickler & Green:	
		18 hours steam-hammer and forge-work, at 75 cents	13.50
		22 hours power-drill work, at 60 cents	13.20
		8 hours planer work, at 60 cents	4.80
		11½ hours lathe work, at 60 cents	6.90
Sept. 16	6	James E. Davis & Co.:	
		1,000 pounds white lead, at $7.31½ per cwt	73.12
		100 pounds red lead	6.82
		25 pounds chrome green at 10½ cents	2.63
		5 pounds ult. marine blue, at 17 cents	.85
		50 pounds dry Turkey umber, at 5½ cents	2.75
		10 pounds American vermillion, at 12 cents	1.20
		50 pounds alabastine (green), at 6½ cents	3.25
		400 pounds iron-ore paint, at 4¾ cents	19.00
		106⅓ gallons linseed oil (raw), at 40 cents	42.77
		100⅓ gallons linseed oil (boiled), at 43 cents	43.34
		10 gallons damar varnish, at $1.35	13.50
		10 gallons hard-oil finish, at $1.50	15.00
		60 gallons turpentine, at 48 cents	28.80
		20 gallons Japan drier, at 69 cents	13.80
		510 gallons kerosene oil, at 10½ cents	53.55
		2 dozen paint brushes (O. K. King), at $8.25	16.50
		1 dozen paint brushes (3–0 round, "O'kalla")	8.70
		¼ dozen sash tools, large, at 85 cents	.43
		¼ dozen sash tools, small, at 25 cents	.12
		1 dozen white-wash brushes (9-inch.),	9.56
		¼ dozen camels'-hair brushes, at 20 cents	.10
		1 dozen large carriage sponges	3.00
		¼ dozen packages stove polish, at 48 cents	.24
		2 only kalsomine brushes, at $1.67 each	3.34
		4 pounds glycerine, at 25 cents	1.00
		25 pounds sal-soda, at 1½ cents	.38

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	Object of expenditure.	Amount.
		October—Continued.	
1886.			
Sept. 16	6	James E. Davis & Co.—Continued.	
		1 box window glass, 14 by 20	$2.63
Aug. 27	7	N. Eisenlord, secretary and treasurer, advertising for "Proposals for supplies"	4.80
Oct. 4	8	George W. Edwards:	
		48 pieces of leather 20 inches diameter, ½-inch thick, at $2.40	115.20
		12 pieces leather 30 inches diameter, ½-inch thick, at $3.90	46.80
		2 pieces sole leather 24 inches diameter, at $3	6.00
		32 feet leather belt, 8 inches wide, at 92 cents	29.44
		58 feet leather belt, 7 inches wide, at 80 cents	46.40
		27 feet leather belt, 4 inches wide, at 22 cents	5.94
Sept. 2	9	Chas. R. Stuart, advertising for "Proposals for supplies"	1.95
		November.	
Nov. 4	1-2	Pay-rolls, October:	
		1 superintendent, 1 month	150.00
		1 clerk, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 foremen, 1 month and 29 days, at $75	147.50
		2 watchmen, 2 months, at $50	100.00
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 1 month and 26½ days, at $50	94.17
		11 lockmen, 10 months and 26 days, at $45	489.00
		2 divers, 6 days, at $10	60.00
		1 carpenter, 260 hours, at 25 cents	65.00
		1 scrubber, 50 hours, at 15 cents	7.50
		1 tinner, 12½ hours, at 30 cents	3.65
		1 blacksmith, 139½ hours, at 30 cents	41.85
		6 laborers, 1,475 hours, at 17½ cents	258.11
Oct. 4	3	N. Eisenlord, secretary and treasurer, advertising for "Proposals for supplies"	3.84
27	4	H. W. Seymour:	
		1,148 feet, B. M., common pine lumber (delivered), at $12 per M	13.77
28	5	George W. Edwards:	
		1 dozen rubber valve-buffers, 2 5/16 inches diameter, ¾ inch thick, and ¾-inch hole in center	5.00
		1 dozen rubber valve-buffers, 5½ inches diameter, ¼ inch thick, and 3-inch hole in center	25.00
Sept. 6	6	T. B. Rayl & Co.:	
		1 dozen R. R. wheelbarrows	17.00
		2 dozen galvanized-iron pails, at $4	8.00
		2 pounds solder (extra), at 15 cents	.30
		½ dozen round files, 12 inches long, at $2	1.00
		½ dozen half-round files, 12 inches long, at $2.82	1.41
		½ dozen flat files, 12 inches long, at $2	1.00
		1½ dozen bastard files, 12 inches long, at $2.40	3.60
		1 dozen flat finishing-files	3.03
		1 dozen hand-saw files	.87
		1 dozen flat files, 8 inches long	1.05
		2 pounds copper rivets and burrs, ½ inch long, at 25 cents	.50
		50 sheets emery paper, No. 1, at $1 per hundred	.50
		100 sheets sand paper, No. 1	.80
		1 keg 4d. shingle nails	2.80
		6 kegs 10d. nails, at $2.05	12.30
		2 kegs 8d. nails, at $2.30	4.60
		1 dozen R. R. shovels (steel)	9.50
		2 only tap-cocks, ¾ inch, at $1	2.00
		½ pound tacks, brass, round head, at $1	.50
		2 pairs strap-hinges, 8 inches, at 12½ cents	.25
		2 only scythes and snaths, at $1.20	2.40
		1 dozen scythe stones	.35
		½ dozen iron garden-rakes, at $2.80	1.40
		23 pounds Jessup's Oct. steel, ¾ inch, at 17 cents	3.91
		150 feet 1-inch gas-pipe, at 7 cents	10.50
		1 dozen 1-inch elbows	1.00
		1 dozen 1-inch unions	1.50
		½ dozen 1-inch T's, at $2.30	1.15
		½ dozen 1-inch plugs, at 30 cents	.15
		1 dozen 1-inch nipples	.65
		2 only hack-saws, 12 inches, at 36 cents	.72
		2 dozen packages screws, 1½ inches, at 17½ cents per package	4.20
		1 dozen packages screws, 2½ inches, at 33 cents per package	3.96
		1 dozen packages screws, 1 inch, at 13 cents per package	1.56
		1 dozen packages screws, ¾ inch, at 9 cents per package	1.08
		1 dozen papers brad nails, 1 inch	1.08
		1 dozen papers brad nails, 1½ inches	.90
		1 dozen papers brad nails, 1¼ inches	.84

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	Object of expenditure.	Amount.
		November—Continued.	
1886.			
Sept. 6	6	T. B. Rayl & Co.—Continued.	
		1 dozen papers brad nails, 2 inches	$0.78
		1 open-grate stove, No. 22	18.00
		2 only fire pots and grates (for No. 50 Garland, 1883), @ $3.65	7.30
		2 sets mica, at $1.75	3.50
		2 ash pans (No. 50 Garland), at 50 cents	1.00
		1 foot rail (No. 50 Garland)	2.25
		1 fire pot and grate (No. 25 Garland)	1.75
		1 ash pan (No. 25 Garland)	.40
		1 set turnbuckles (No. 25 Garland)	.65
		1 foot rail (No. 25 Garland)	2.00
		1 set mica	1.00
		10 pounds stove cement, at 5 cents	.50
		1 set mica (No. 4 Argand)	1.75
Oct. 8	7	George W. Edwards:	
		3 bales oakum, "best," at $3.90	11.70
		10 barrels salt, at $1.51	15.10
		4 dozen broome (extra heavy), at $2.85	11.40
		50½ gallons lard oil (extra), at 50 cents	25.25
		2 boxes laundry soap, at $4.35	8.70
		2 cases matches, "Telegraph" at $1.25	2.50
		50 yards unbleached cotton, at 6 cents	3.00
		10 yards red flannel, at 35 cents	3.50
		542 pounds white cotton waste, at 9½ cents	51.49
		5 pounds candle wicking, at 20 cents	1.00
	9	12 square feet lace leather, at 25 cents	3.00
		17½ pounds rubber gasket, ⅛-inch, at 22 cents	3.80
		11½ pounds cotton packing (white), at 25 cents	2.88
		50 feet 1½-inch steam hose, 6 ply, at 62 cents	31.00
		1 dozen scrubbing brushes	1.75
		2 stove brushes and daubers, at 50 cents	1.00
		5¾ pounds mater twine, at 25 cents	1.44
		2 barrels lime, at $1.10	2.20
		1 U. S. Ensign, 20 feet by 10 feet	18.00
		1 U. S. Ensign, 12 feet by 6 feet	8.00
		December.	
Dec. 3	1-2	Pay-rolls, November:	
		1 superintendent, 1 month	150.00
		1 clerk, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 foremen, 1 month and 29½ days, at $75	148.75
		2 watchmen, 2 months, at $50	100.00
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 2 months, at $50	100.00
		11 lockmen, 10 months and 27½ days, at $45	491.25
		1 carpenter, 252½ hours, at 25 cents	63.12
		1 scrubber, 40 hours, at 15 cents	6.00
		1 machinist, 20½ hours, at 30 cents	6.05
		1 tinner, 5 hours, at 25 cents	1.25
15	3	R. A. Catton, cashier:	
		Expressage on 1 box of official books and papers from Sault Ste. Marie to Detroit, Mich., 190 pounds	7.80
14	4	Andrew Jackson, clerk:	
		Traveling expenses from Sault Ste. Marie to Detroit, Mich	18.00
1	5	E. D. Johnson:	
		296 feet B. M., white pine, at $15 per M	4.14
		256 feet B. M., white pine, at $12 per M	3.07
		156 feet B. M., white pine, at $15 per M	2.34
		1,241 feet B. M., white pine, at $12 per M	14.89
		225 feet B. M., dressed pine, at $16 per M	3.60
		1,100 feet B. M., rough boards, at $14 per M	15.40
		1,300 feet (face measure) pine flooring, 2½ inches wide, at $30 per M	39.00
		252 feet dressed battens, at $16 per M	4.03
		333 linear feet casing, at $30 per M	9.99
		130 linear feet 3-inch molding, at 2¼ cents	2.92
		1,000 feet B. M., dressed boards	20.00
		12,000 pine shingles (sawed), at $4.25 M	51.00
		3 4-light window sash, 16 inches by 28 inches glazed, at $2.80	8.40
		4 pairs wrought butts, 4 inches by 4 inches, at 20 cents	.80
		3 bronze latches, at $1.50	4.50
		2 dead locks, 3 inches by 5 inches, at $1.25	2.50
		3 bronze sash fasteners, at 35 cents	1.05
		10 wardrobe locks, at 75 cents	7.50
		6 dozen coat and hat hooks, at 25 cents	1.50
		1,000 red bricks	12.00

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	Object of expenditure.	Amount.
		December—Continued.	
1886.			
Dec. 1	5	E. D. Johnson—Continued.	
		5 barrels lime, at $1	$5.00
		Cartage on 7,339 feet lumber, at 50 cents per M	3.66
31	6	George H. Smith:	
		Hire of 1 storage-room in Detroit, Mich., from October 1 to December 31, 1886 (both dates inclusive), 3 months, at $100 per year	25.00
	7	Andrew Jackson:	
		Services as clerk from December 1 to December 31, 1886 (both dates inclusive), being 1 month	150.00
1887.		*January.*	
Jan. 4	1	Pay-roll, December, 1886:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 10 days, at $80 per month	26.66
		2 foremen, 20 days, at $75 per month	50.00
		2 watchmen, 20 days, at $50 per month	33.32
		2 watchmen, 1 month and 10 days, at $45	60.00
		2 lockmen, 20 days, at $60 per month	40.00
		2 lockmen, 19 days, at $50 per month	31.66
		11 lockmen, 3 months and 9 days, at $45	148.50
		2 divers, 1½ days, at $10	15.00
31	2	Andrew Jackson, services as clerk from January 1 to January 31, 1887 (both days included), being 1 month	150.00
	3	Pay-roll, January, 1887, office superintendent engineer, Detroit, Mich.:	
		2 clerks, 2 months, at $175	350.00
		1 clerk, 1 month	100.00
		1 copyist, 1 month	35.00
		1 office attendant, 1 month	50.00
		1 messenger, 1 month	50.00
		1 scrubber, 1 month	5.00
		February.	
Feb. 3	1	Pay-roll, January, 1887:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 watchman, 1 month	45.00
4	2	Thomas Williamson, Manager Detroit Free Press Printing Company, 300 copies of specification, etc., for furnishing timber and lumber for lock-gates at St. Mary's Falls Canal, Michigan	12.32
28	3	Andrew Jackson, services as clerk, from February 1 to February 28, 1887 (both dates inclusive), being 1 month	150.00
		March.	
Mar. 4	1	Pay-roll, February, 1887:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 watchman, 1 month	45.00
15	2	N. Eisenlord, secretary and treasurer The Detroit Free Press Company, inserting advertisement for timber and lumber 6 times	3.84
15	3	T. G. Russell, treasurer Parker-Russell Mining and Manufacturing Company:	
		1½ dozen bright globes, 14 inches in diameter, at $12	18.00
		1 dozen ground globes, 12 inches in diameter	12.00
		6,000 carbons (copper coated), at $13.50	81.00
		400 feet electric light cable, at 6 cents	24.00
		2 only dust brushes, at 25 cents	.50
		1 dozen cut-out switch magnetic spools	30.00
31	4	George H. Smith, rent of one storage-room in Detroit, Mich., from January 1 to March 31, 1887 (both days inclusive), being 3 months, at $100 per year	25.00
	5	Andrew Jackson, services as clerk from March 1 to March 31, 1887 (both days inclusive), being 1 month	150.00
		April.	
April 5	1	Pay-roll, March, 1887:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineman, 1 month	90.00
		1 engineman, 24 days, at $80 per month	64.00
		2 foremen, 12½ days, at $75 per month	31.25
		2 watchmen, 15 days, at $50 per month	25.00
		2 watchmen, one month and 3½ days, at $45	50.25
		2 lockmen, 1 month and 2 days, at $60 per month	64.00
		2 lockmen, 16 days, at $50 per month	26.66
		9 lockmen, 2 months and 11 days, at $45	108.50

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	Object of expenditure.	Amount.
1887.		*April*—Continued.	
Apr. 26	2	H. L. Wilton:	
		12 cut-out fiber insulation, at 35 cents	$4.20
		12 small dial carbons	.60
		Postage on above, Detroit to Sault Ste. Marie, Mich	.15
		May.	
May 2	1	Andrew Jackson, services as clerk from April 1 to April 10, 1887 (both days inclusive), being 10 days, at $150 per month	50.00
5	2, 3	Pay-rolls, April, 1887:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 engineer, 1 month	90.00
		1 engineer, 1 month	80.00
		2 foremen, 1 month and 24½ days, at $75	136.25
		2 watchmen, 1 month and 23 days, at $50	88.33
		2 watchmen, 1 month and 26½ days, at $45	84.75
		2 lockmen, 1 month and 29 days, at $60	118.00
		2 lockmen, 2 months, at $50	100.00
		11 lockmen, 10 months and 12 days, at $45	468.00
		1 carpenter, 235 hours, at 25 cents	58.75
		2 laborers, 156½ hours, at 17½ cents	27.37
17	4	Hickler & Green:	
		50 hours' work on lathe, at 60 cents	30.00
		10 hours' work with drill, at 60 cents	6.00
		31⅔ hours' work on planer, at 60 cents	19.09
26	5	Andrew Jackson, clerk, traveling expenses from Detroit to Sault Ste. Marie, Mich	9.00
		June.	
June 4	1, 2	Pay-rolls, May:	
		1 superintendent, 1 month	150.00
		1 clerk, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		2 foremen, 2 months, at $75	150.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 watchmen, 1 month and 26 days, at $50	93.33
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 2 months, at $50	100.00
		11 lockmen, 10 months and 28½ days, at $45	492.75
		1 carpenter, 255 hours, at 25 cents	63.75
		1 scrubber, 40 hours, at 15 cents	6.00
		2 teams, 30 hours, at 40 cents	12.00
		1 tinner, 7 hours, at 28½ cents	1.99
		7 laborers, 1,649½ hours, at 17½ cents	288.65
		July.	
July 5	1, 2	Pay-rolls, June:	
		1 superintendent, 1 month	150.00
		2 assistant superintendents, 2 months, at $100	200.00
		1 clerk, 1 month	150.00
		1 engineman, 1 month	90.00
		1 engineman, 1 month	80.00
		2 foremen, 1 month and 29 days, at $75	147.50
		2 watchmen, 1 month and 24½ days, at $50	90.83
		2 watchmen, 2 months, at $45	90.00
		2 lockmen, 2 months, at $60	120.00
		2 lockmen, 2 months, at $50	100.00
		11 lockmen, 10 months and 24½ days, at $45	486.75
		1 foreman, 4 days, at $75 per month	10.00
		1 carpenter, 260 hours, at 25 cents	65.00
		1 scrubber, 40 hours, at 15 cents	6.00
		1 tinner, 15½ hours, at 25 cents	3.81
		12 laborers, 2,762½ hours, at 17½ cents	483.43
8	3	George H. Smith, rent of one storage-room in Detroit, Mich., from April 1 to June 30, 1887 (both days inclusive), being 3 months, at $100 per year	25.00
6	4	H. W. Seymour, 5,000 feet, B. M., common pine boards, delivered at canal, at $12 M	60.00
		Total	22,138.92

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K K 3.

DRY-DOCK AT ST. MARY'S FALLS CANAL, MICHIGAN.

There is nothing to add to the subject-matter of preceding reports in regard to this work beyond the fact that the construction of the cofferdam inclosing the site of the proposed lock at St. Mary's Falls Canal has reached that stage which renders necessary the tracing out of the walls of the old lower lock, and therefore all projects aiming at converting the old State locks into a dry-dock must be considered as disposed of.

The proposition to locate a dry-dock in immediate proximity to the lockage system is as objectionable as ever; but if it should be decided to do so, then the location heretofore referred to, at the eastern end of the area transferred from the Fort Brady military reservation to the canal reservation, is the least objectionable.

Amount (estimated) required for the construction of a dry-dock at the point indicated	$323,872
Amount that can be profitably expended in fiscal year ending June 30, 1889.	150,000

which should be added to the $65,000 (more or less) which it is understood the State of Michigan holds in readiness to transfer to the United States for the purpose of constructing a dry-dock at St. Mary's Falls Canal.

K K 1.

IMPROVEMENT OF HAY LAKE CHANNEL, ST. MARY'S RIVER, MICHIGAN.

The original estimates for this improvement were based upon a project for a channel 300 feet wide and 17 feet deep, leaving the present navigable channel of St. Mary's River at Sugar Island Rapids (about 2¼ miles below the canal), through these into Hay Lake, and then, by way of the Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles, and obtaining a route which it is practicable to so mark with lights as to be navigable at night, a condition impracticable with the present channel.

The estimated cost of this project was $2,127,292. The project was subsequently modified to increase the depth to 19 feet, and this has been further increased to 20 feet.

The estimated cost of the present project is $2,659,115, subject, however, to change should unexpected difficulties be developed during the progress of the work.

Three appropriations have been made for the work, as follows:

By act of Congress passed August 2, 1882	$200,000
By act of Congress approved July 6, 1884	125,000
By act of Congress approved August 5, 1886	150,000
Total	475,000

The improvement naturally divides into three parts. Beginning with the up-stream part they are

(1) Channel through Sugar Island Rapids.
(2) Channel through Middle Neebish.
(3) Channel at Sailor's Encampment.

Except a few test-pits at Sugar Island Rapids, the work of excavation has thus far been prosecuted only at Middle Neebish and Sailor's Encampment, and during the past year at Middle Neebish only. No

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difficulty concerning right of way existed at either locality, but the channel at Sugar Island Rapids must for a portion of the distance pass through private property, and provision should be made in the next appropriation bill for acquiring title, in order that the work may not be delayed. If absolute title in fee-simple is insisted upon, this will be somewhat costly, probably $10,000 for a strip 400 feet wide. If simple right of way will satisfy the Government, this can be obtained at a nominal price. I recommend the former, however.

The following is a statement of the progress made in the excavation of Hay Lake Channel from the beginning to the 30th June, 1887:

In 1883 several test-pits were dug in Sugar Island Rapids, but since no soundings for estimates have been taken here; scow measurement is necessarily given.

CONTRACTS, ETC.

	Cubic yards, bank measure.
Middle Neebish:	
February 28, 1883	201,080
September 5, 1884	59,411
May 18, 1885	58,583
Experimental work (drill and dredge)	36,113
Test-pits, Sugar Island Rapids (scow measure)	1,160
At Sailor's Encampment	6,644
Total	362,991

PRESENT CONDITION OF CHANNEL THROUGH MIDDLE NEEBISH.

The latest soundings show that all of the sections have a depth of water of more than 15 feet in some parts, and that all but 145 sections have a depth of more than 10 feet. But these depths are generally for only very narrow widths.

During the fiscal year operations have been carried on under contracts as follows:

(1) With Hickler & Green, contract dated May, 18, 1885. Although the contract was terminated June 30, 1886, as reported in the last annual report, it was not closed until August 3. The total amount excavated under this contract was 65,128 cubic yards, but only 58,330 cubic yards were paid for, the remainder having been excavated beyond the contract limits and therefore not included in the estimates. At the contract price of 89 cents per cubic yard the sum paid was $51,913.70.

(2) With Hickler & Green, contract dated December 24, 1886, for excavation at Middle Neebish, at $1.95 per cubic yard. This contract is for a channel 20 feet deep and 300 feet wide at bottom, beginning at cross-section 509, and extending down-stream as far as the available funds will permit. The contractors have had three dredges at work since May 12, 1887. They have erected a house for the manufacture of explosives; also an ice-house, and have added to their plant a new drill-scow carrying two steam-drills. Much excavation has been done under this contract, but no estimate has yet been made for payment, because the contractor is not entitled to payment until the full depth is attained.

(3) With Williams & Upham for a dredge, tug, and two dump-scows, at a rate of $8 per hour of actual work, contract dated August 13, 1884. This contract was terminated with the close of the working season of 1886.

Altogether the following plant was used on the work during the fiscal year, viz:

One tug, one drill-scow (with single drill), and one quarters-boat belonging to the Government. A dredge, tug, and two dump-scows under the Williams & Upham contract, and one drill-scow (with double drill),

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three dredges, three tugs, six dump-scows, two wood-scows, and one coal-scow under the Hickler & Green contract.

The tug, drill-scow, and quarters-boat belonging to the Government were calked, painted, and put in good repair during April and May, 1887.

Experimental drilling, blasting, and dredging in Middle Neebish were continued during the working season of 1886. Work with the drill-scow began May 11, and, with but two delays, extended to November 15.

The area drilled and blasted was about 35 feet wide between cross-sections 544 and 644 and longitudinal sections 17 and 41. The holes were drilled to a grade of 23 feet, and were 5 by 6 feet apart. The depth of the holes varied from 6 to 9½ feet, but were generally about 8 feet deep. The number of working days was 127; holes drilled, 1,343; number of exploders used, 1,470; and the amount of powder, 5,291½ pounds of Hercules No. 2. The average per day was ten holes, 42 pounds of powder, and 11½ exploders.

At one place, on account of a seam in the rock, 23 feet below the surface of the water, through which the force of the explosion was wasted, it was found necessary to redrill, carrying the holes only to 21½ feet, thus obtaining satisfactory results.

The cost of operating the drill-scow and tug was $6,798.24, or $53.53 per day.

The dredge under contract by the hour worked on the blasted area 849$\frac{4}{60}$ hours, at a cost of $6,792.53, and excavated 7,590 cubic yards (scow measurement) of sandstone rock. The cut was made as deep as possible, giving from 20½ to 22½ feet of water. From soundings taken in November, the bank measurement above the 20-foot grade was found to be 5,911 cubic yards; and one-half the amount, between 20 and 21 feet, was ascertained to be 352 cubic yards, thus making a total of 6,263 cubic yards under our method of estimating for contract work. The amount of scow measure exceeded the bank measure by 21½ per cent. The cost for dredging was $1.08½ per cubic yard, bank measure.

The cost for drilling and blasting having been $6,798.24, the total cost for excavating 6,263 cubic yards, bank measure, was $13,590.79, or $2.17 per cubic yard. The dredge was also employed 1,336$\frac{58}{60}$ hours, at a cost of $10,695.73, in widening the 100-foot channel between sections 490 and 841. As no blasting was done, the depth of the cut varied from 13 to 22 feet. The total excavation was 15,715 cubic yards, scow measure, or 10,068 cubic yards, bank measure, above the 20-foot grade. In this instance the scow measure exceeds the bank measure by 56 per cent. The cost of dredging was $1.06 per cubic yard, bank measure.

From an examination of the work already done, it is estimated that for a channel 300 feet wide, between cross-sections 500 and 850, about two-fifths of the material will have to be blasted, the remaining three-fifths being dredgable without. The cost per cubic yard, bank measure, for the season's experimental work was $2.17 and $1.06, respectively, the average being $1.50 per cubic yard.

The cost per yard for making the cut of full width, as we are now doing, is somewhat less than it would be in making a series of parallel cuts. Moreover, no account was made of the side slopes which would be necessary on the last side cuts of a 300-foot channel.

These items are considered as an offset to the reduced cost that might result from a larger drill plant, etc. As ridges will be left in making wide cuts, it is estimated that it will add 20 per cent. to the first cost to "clean up" the bottom to a 20-foot grade, thus making the final cost $1.80 per cubic yard.

The following is a statement of the cost of the experimental work of

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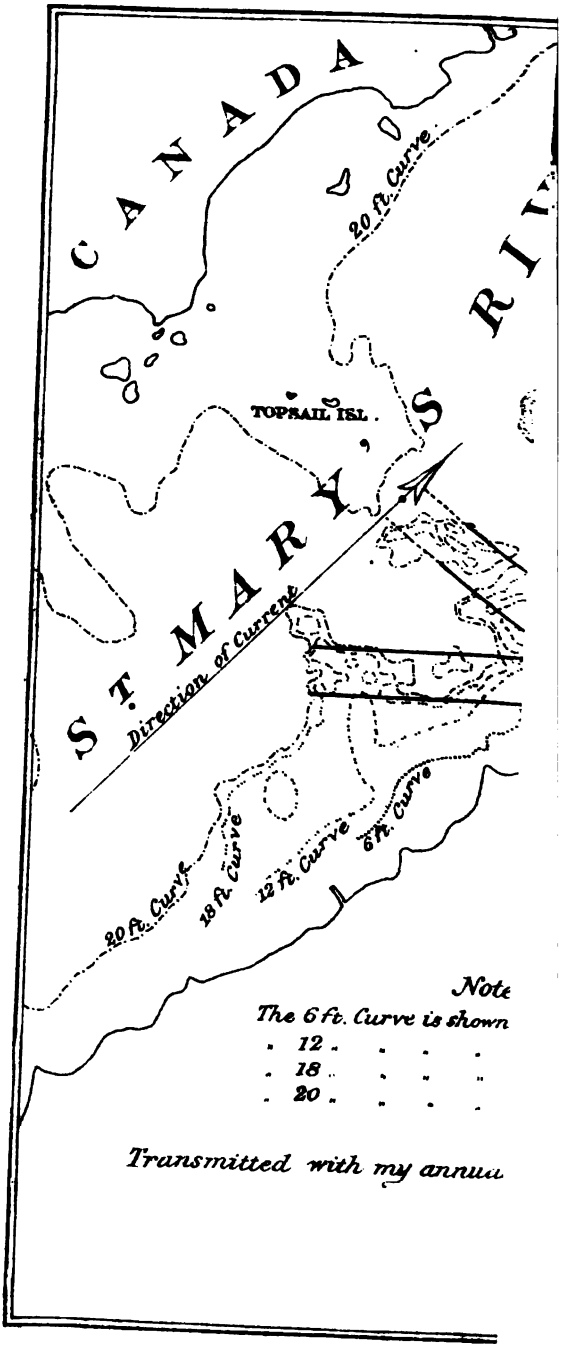

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excavating the sandstone rock in the Middle Neebish during the past three seasons, viz:

Years.	Experimental work.	Cubic yards, bank measure.	Cost per cubic yard, bank measure.	Total cost.
1884	Blasted and scraping	6,850	$1.34	$8,918.65
1885	do	2,991	1.47	4,397.23
	Blasted	2,600	2.51	6,524.54
1886	do	6,263	2.17	13,590.77
	Scraping	10,068	1.06	10,695.73
Total		28,772	1.53	44,126.92

That part of the work of 1885 and 1886 costing $2.51 and $2.17 per yard, respectively, was where the softer material had been removed, so that on the rock requiring blasting there was from 14 to 19 feet of water. This, of course, made the cost per yard greater than where both the soft and hard materials were included. The average cost ($1.53) agrees closely with that estimated for the 300-foot channel.

SURVEY OF SOUTH QUARTER OF 300-FOOT CHANNEL THROUGH MIDDLE NEEBISH.

Soundings have been made over an area 100 feet wide and 12,740 feet long on the south side of the present channel in Middle Neebish. These soundings were made in the same manner and with the same care as those of preceding surveys (described at page 1837, Annual Report of the Chief of Engineers, 1883). This completes the surveys necessary for a channel 300 feet wide through Middle Neebish.

SURVEY OF ROUTES THROUGH SUGAR ISLAND RAPIDS.

Inspection of the data previously existing showed that the choice of routes through Sugar Island (or Little) Rapids was practically limited to two, as indicated upon the accompanying sketch, where they are respectively designated Route No. 1 and Route No. 2.

The necessary surveys to obtain the data to enable us to choose between them were begun in 1885. A system of triangulation was started from Triangulation Station 14, survey of 1879 (Topsail Island), and Triangulation Station 4, survey of 1872. This was carried through the rapids down to Six-mile Point, in Hay Lake. Ten tripod stations were built and marked by stones placed 3 feet under ground. The angles were measured with a Pistor & Martin transit and the triangles computed. As opportunity offered during 1885 and 1886 both routes, wherever obstructed by brush, were cleared for a width of 400 feet.

Soundings below water-surface and levels above were taken on Route No. 1 over an area 24,000 feet long and 400 feet wide, and on Route No. 2 over an area of the same width, but 200 feet longer. Cross-sections on the former were located 50 feet apart and on the latter 100 feet. Soundings were taken at every 10 feet on each section, or nearly 29,000 in all.

In July, 1886, two lines of tamarack stakes were driven 400 feet apart, the consecutive stakes on each line being 500 feet apart. The position of each stake was determined by transit intersections from two shore stations. Eight men were engaged on the survey, viz, 1 assistant engineer, 1 subinspector, and 6 laborers.

The soundings were located as follows, viz:

Two side lines, each 500 feet long and one-fourth inch in diameter, on which were fastened cedar corks at intervals of 50 feet, were

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stretched between consecutive stakes on the side lines. Two small boats, in each of which were two men, were anchored at corresponding corks on the side lines. A steel wire, one-eighth inch in diameter, which was tagged every 10 feet for 400 feet, was stretched between the side boats, and then the soundings were taken from a third boat, with a sounding-pole 24 feet long, at each tag on the cross line.

Water-gauge readings were taken quarter-hourly at gauges opposite the work. Six gauges were established from the head to the foot of the rapids. Six days of quarter-hourly readings were taken at the six gauges and the gauge on the northeast pier below the locks at St. Mary's Falls Canal. The results are given in the following table, viz.:

Date.	Fall of the water's surface between the gauge on northeast pier and the several gauges at Sugar Island Rapids.							
	N. E. Pier.	A	B	C	D	E	F	G
1886.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
September 24, a. m	0.0	—0.051	—0.457	—0.467	—0.515	—0.584	—0.604	.....
September 24, p. m	0.0	—0.041	—0.388	—0.429	—0.435	—0.444	—0.527	.....
September 25, a. m	0.0	—0.043	—0.493	—0.524	—0.575	—0.592	—0.672	.....
September 25, p. m	0.0	—0.047	—0.438	—0.479	—0.507	—0.533	—0.608	.....
October 21, a. m	0.0	—0.038	—0.568	.....	—0.626	—0.655	—0.738	—0.813
October 21, p. m	0.0	—0.047	—0.487	—0.481	—0.536	—0.564	—0.639	—0.707
October 22, a. m	0.0	—0.050	—0.546	—0.607	—0.666	—0.686	—0.783	—0.861
October 22, p. m	0.0	—0.050	—0.566	—0.599	—0.649	—0.659	—0.744	—0.814
October 28, a. m	0.0	—0.046	—0.538	—0.595	—0.635	—0.660	—0.739	—0.822
October 28, p. m	0.0	—0.043	—0.594	—0.620	—0.657	—0.688	—0.763	—0.847
October 30, a. m	0.0	—0.040	—0.479	—0.514	—0.554	—0.584	—0.650	—0.719
October 30, p. m	0.0	—0.032	—0.531	—0.535	—0.575	—0.601	—0.679	—0.731
Sums	0.0	—0.528	—6.084	—5.850	—6.930	—7.200	—8.146	—6.324
Mean of fall between northeast pier and the several gauges	0.0	—0.044	—0.507	—0.532	—0.577	—0.600	—0.679	—0.790
Mean of fall between successive gauges	0.0	—0.044	—0.463	—0.025	—0.045	—0.023	—0.079	—0.111

A bench-mark was established near each gauge, and eight bench-marks were established on the islands and alongside of Route No. 1. The elevations of these bench-marks were determined by duplicate lines of precise levels, and are as follows, viz:

Bench-marks.	Elevation above canal datum.	Elevation above mean tide at New York.
	Feet.	*Feet.*
F, on lock-wall	120.154	606.024
A	101.904	587.774
a	102.083	587.953
14	100.242	586.112
E. S. Wheeler's	99.998	585.868
B	103.730	589.600
13	100.548	586.418
C	102.936	588.806
D	99.823	585.693
12	101.189	587.059
F	98.442	584.312
G	102.794	588.664
11	111.465	597.335
H	100.637	586.507
I	101.443	587.313
K	102.398	588.268
L	105.278	591.148
M	102.687	588.557
N	99.937	585.807
O	101.973	587.843
P	102.651	588.521
15	99.887	585.757

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All the soundings have been reduced to a uniform water-surface 20 feet above a grade line, the elevation of the various parts of which are as follows, viz:

Cross-sections.	Elevation of grade-line above canal datum.
	Feet.
From 0 to 70	77.9
From 70 to 110	77.6
From 110 to 150	77.5
From 150 to 190	77.4
From 190 to 230	77.3
From 230 to 350	77.2
From 0 to 140, angle below Frechette's Creek	77.1

Sounding was begun August 6 and completed October 9, 1886.

The computations have been made for channels of 20 feet deep and 300 feet wide, with side slopes of 2 horizontal to 1 vertical.

On Route No. 1 the amount of excavation for such a channel would be 2,052,848 cubic yards, and the estimated cost of the whole route would be—

2,052,848 cubic yards excavation, at 15 cents	$307,927
600 linear feet of pier, for shutting off side channels, at $40	24,000
Add 15 per cent. for purchase of right of way, contingencies, etc	49,789
Total	381,716

The amount of excavation on Route No. 2 would be 1,954,499 cubic yards, exclusive of an area 300 feet by 800 feet at the upper end, over which soundings were not taken.

The estimated cost for this route is as follows, viz:

1,954,500 cubic yards dredging, at 15 cents	$293,175
Dredging area 300 by 800 feet	15,000
1,500 linear feet pier at upper end, at $32.50	48,750
35,555 cubic yards stone filling for back of pier, at 40 cents	14,222
Dredging for piers	3,000
600 linear feet pier for shutting off side channels, at $40	24,000
Add 15 per cent. for purchase of right of way, contingencies etc	59,722
Total	457,869

The advantages of Route No. 1 are:

(1) It is straight throughout.

(2) The estimated cost is $76,153 less than by the other.

(3) It is 2,000 feet shorter from where the two routes separate above Topsail Island to their junction below the rapids.

(4) It has one course less than the other. The number of range lights required to mark the two would probably be the same, however, as the extra course in Route No. 2 would be only 1,500 feet long, and opposite to where a range light for another division would probably be located.

(5) The angle of deflection of Route No. 1 from the river channel above Sugar Island Rapids is 40° 36′. The channel at this angle is about 1,000 feet wide, with a depth of from 25 to 35 feet, and the direction of the current is only slightly across that of Route No. 1, so that tows would have plenty of room to swing in, and could make the turn without difficulty or danger.

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On Route No. 2 the angle of deflection is 80° 20′. The channel as estimated would be only 300 feet wide, and there would be a swift current almost at right angles with it. It would be both difficult and dangerous for tows to make the turn, and almost impossible for boats to pass one another safely moving in opposite directions and meeting at the angle.

(6) The right of way through private property can probably be secured at a less cost by Route No. 1.

(7) By adopting Route No. 1 the entire shore-line is left for commercial purposes.

(8) If the necessities of commerce should ever require that the channel be widened or deepened, the cost of doing so would be less by Route No. 1.

(9) Because Route No. 1 is straight, and its two ends intervisible, it would be more easily and safely navigated by approaching boats.

The advantages of Route No. 2 are:

(1) A probably slower current.

(2) A channel could be opened by this route for tugs and local craft for less than half the cost by the other route.

Considered together, the advantages of Route No. 1 are so much greater than those of the other that there cannot be a moment's doubt as to the propriety of its adoption, and the estimates herewith submitted are therefore based upon Route No. 1.

GENERAL REMARKS.

Mr. E. S. Wheeler, assistant engineer, had local charge of all the engineering operations upon St. Mary's River and Canal, and has performed his duties to my satisfaction.

Assistant Engineer Joseph Ripley had general charge of the work at Middle Neebish, and has personally made the surveys and estimates both there and at Sugar Island Rapids.

Mr. R. Common, jr., sub-inspector to May 16, 1887, and inspector since, has aided Mr. Ripley in the field, and has had special charge of the books and accounts.

Sub-inspector Frank Reed had charge of the dredge employed by the hour until termination of the contract. He is now employed at the canal in the same capacity.

Patrick Collins had charge of the drill-scow, and W. W. McNaughton of the United States tug *Myra*.

The advantages of this improvement have been so fully set forth in preceding reports, notably beginning at page 2362 of the Annual Report of the Chief of Engineers for 1882, page 1836 of the Report for 1883, page 2004 of the Report for 1884, and page 2098 of the Report of 1885, that it is not deemed necessary to repeat them.

It is an important part of the system for the amelioration of the general navigation of the Great Lakes, and if it had been available during the fiscal year just closed it would have been used by vessels carrying more than 4,900,000 tons of freight and 30,000 passengers.

The first estimates for this work were those of the late Lieutenant-Colonel Weitzel, Corps of Engineers, amounting to $2,127,292, submitted with his report dated January 14, 1882, printed as House Ex. Doc. No. 54, Forty-seventh Congress, first session, and at pages 2362 *et seq.* of the Annual Report of the Chief of Engineers for 1882, being based upon a project which contemplated a channel-depth of 17 feet.

The project having been modified with a view to a depth of 20 feet, a modification of the estimates will probably be required, but the

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work has not yet sufficiently advanced to determine whether the sum ($2,659,115) obtained by simply increasing by 25 per cent. the estimate for a 17-foot channel is greatly in error. I am inclined to think it is not. It will depend in some degree upon the rate at which appropriations are made. With larger appropriations better contracts can be made, and at the same time the ratio of contingent expenses reduced.

Thus far the appropriations have not been sufficient to warrant undertaking operations at more than one locality. But they should now be begun at Sugar Island Rapids, without at the same time reducing them at Middle Neebish. At the present rate (an average of about $100,000 per year) it will take more than twenty-five years to complete the work.

With a view to more rapid progress and greater economy in carrying on this important work, which everybody admits should be made available as soon as possible, the sum of at least $500,000 should be appropriated, one-half to be spent at each of the two localities named above, and the appropriation should especially be coupled with authority to purchase the necessary right of way, the cost thereof to be paid from the appropriation.

At present this channel has no commerce worth mentioning, nor will it have until it is made navigable for the through traffic, when its commerce will be practically measured by that through St. Mary's Falls Canal, a statement of which is given in connection with the report on operating and care of that work.

Ordinarily this, in common with all other improvements along the water-route between Lake Superior and the lower lakes, is spoken of as a Michigan work, whilst the fact is that Michigan's interest is only about 17 per cent., the remainder pertaining to New York, Pennsylvania, Ohio, Illinois, Wisconsin, Minnesota, Dakota and Montana Territories, and the Dominion of Canada.

Estimated cost of 20-foot channel (subject to revision)	$2,659,115
Appropriated to date	475,000
Amount yet to be appropriated	2,184,115

The work is located in the collection district of Superior, Michigan; Marquette is the nearest port of entry, but Sault Ste. Marie is a sub-port.

The nearest light-house is the beacon on the pier at the western end of St. Mary's Falls Canal.

Money statement.

July 1, 1886, amount available		$33,878.27
Received from sale of fuel	$28.13	
Received from repayment of disallowance	6.75	
		34.88
Amount appropriated by act approved August 5, 1886		150,000.00
		183,913.15
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	29,644.10	
July 1, 1887, outstanding liabilities	1,728.76	
		31,372.86
July 1, 1887, amount available		152,540.29

Amount (estimated) required for completion of existing project	2,184,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids for supplies, etc., required for use in connection with the work of improving Hay Lake Channel, Sault Ste. Marie River, Michigan, received and opened on July 19, 1886, in accordance with advertisement dated July 8, 1886.

[No bidders for vegetables, etc.]

No.	Names and addresses of bidders.	Supplies, etc.	Amount.
*1	George W. Edwards, Detroit, Mich	Ship chandlery	$70.33
*1	James L. Fisher, Detroit, Mich	Hardware	212.12
*1	E. D. Johnson, Sault Ste. Marie	Lumber	99.77
*1	Hickler & Green, Sault Ste. Marie, Mich.	Lathe work, per hour	.60
*1	do	Planer work, do	.60
*1	do	Steam-hammer work, do	.75
*1	do	Bolt-cutter work, do	.60
*1	do	Power-drill work, do	.60
*1	Hull Brothers, Detroit Mich	Subsistence stores	175.87
2	G. & R. McMillan, Detroit, Mich	do	175.92
3	David Wallace, Detroit, Mich	do	183.41

*Recommended for acceptance.

Abstract of bids for improving Hay Lake Channel, Saint Mary's River, Michigan, excavating at Middle Neebish, received and opened on October 14, 1886, in accordance with advertisement dated September 14, 1886.

No.	Names and addresses of bidders.	Excavating above 20-foot grade, price per cubic yard in bank.
1	Henry M. Youmans, East Saginaw, Mich	$2.50
2	Hickler & Green, Sault Ste. Marie, Mich	2.98
3	Carkin, Stickney & Cram, East Saginaw, Mich	3.20
4	Charles S. Barter, Duluth, Minn	3.80
5	L. P. & J. A. Smith, Cleveland, Ohio	4.00
6	Green Bay Dredge and Pile Driver Company, Green Bay, Wis	4.05
7	William Upham & Co., Duluth, Minn	4.50
8	George Talbot, Buffalo, N. Y	5.00
9	Truman & Cooper, Manitowoc, Wis	6.50

Abstract of bids for improving Hay Lake Channel, Saint Mary's River, Michigan, "excavating at Middle Neebish," received and opened on December 16, 1886, in accordance with advertisement dated November 16, 1886.

No.	Names and addresses of bidders.	Excavating above 20-foot grade, price per cubic yard in bank.
*1	Hickler & Green, Sault Ste. Marie, Mich	$1.95
2	Carkin, Stickney & Cram, East Saginaw, Mich	2.65
3	L. P. & J. A. Smith, Cleveland, Ohio	3.00
4	Charles S. Barker, Duluth, Minn	3.80
5	William Upham, & Co., Duluth, Minn	4.80

*Recommended for acceptance.

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Abstract of bids for furnishing supplies for improving Hay Lake Channel, St. Mary's River, Michigan, received and opened April 30, 1887, in accordance with advertisement dated March 31, 1887.

No.	Names and addresses of bidders.	Supplies.	Amount.
1	T. B. Rayl & Co., Detroit, Mich*	Hardware	$189.21
2	J. T. Wing & Co., Detroit, Mich	do	200.10
3	Hodgson & Howard, Detroit, Mich	do	202.15
1	George W. Edwards, Detroit, Mich*	Ship chandlery	893.24
2	J. T. Wing & Co., Detroit, Mich	do	880.47
3	Thomas J. P. Donaldson & Co., Detroit, Mich†	do	
1	John Spry Lumber Co., Sault Ste. Marie, Mich‡	Lumber	218.87
1	Aetna Powder Co., Chicago, Ill*	Hercules powder	1,010.00
2	N. T. Norcross, Cleveland, Ohio	do	1,011.25
1	George Kemp, Sault Ste. Marie, Mich*	Coal	668.00
1	Hull Brothers, Detroit, Mich*	Groceries	419.92
2	G. & R. McMillan, Detroit, Mich	do	422.06
3	David Wallace, Detroit, Mich	do	436.77
4	Jacob Hull & Co., Detroit, Mich	do	447.61
1	C. C. Johns, Sault Ste. Marie, Mich*	Vegetables	388.85
2	Alexander Grieve, Sault Ste. Marie, Mich	do	392.05
3	Henry L. Newton, Sault Ste. Marie, Mich	do	447.75
1	Alexander Grieve, Sault Ste. Marie, Mich*	Fresh meats	255.00
2	C. C. Johns, Sault Ste. Marie, Mich	do	262.50
3	Henry L. Newton, Sault Ste. Marie, Mich	do	300.00
1	H. E. Hungerford, Sault Ste. Marie, Mich*	Hardwood	209.50

* Recommended for acceptance.
† Incomplete.
‡ Incomplete; no bid on white oak. Balance recommended for acceptance.

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IMPROVEMENT OF HARBOR AT CHEBOYGAN, MICHIGAN.

Prior to undertaking any improvement of this harbor, only 6½ to 7 feet of water could be carried across the bar at the mouth of Cheboygan River.

The original project for the improvement, adopted in 1871, contemplated dredging a channel 200 feet wide and 14 feet deep through the bar and revetting each side by a sheet-pile pier, at an estimated cost of $395,335.

A history of the progress of the work of improvement to the year 1876 is given at pages 530 and 531, Report of the Chief of Engineers for 1876. By the close of the fiscal year 1875–'76 the channel was 13 feet deep, with a minimum width of 130 feet.

The expenditure of $10,000, appropriated by the act of August 14, 1876, resulted before the close of the season of 1877 in widening the channel to 150 feet and making a winding place for vessels opposite the steamboat dock 200 feet wide, the depth being 13 feet throughout. With the appropriation of $8,000 by act of June 18, 1878, and $3,000 by that of March 3, 1879, the improvement was carried to the full width of 200 feet throughout. By the close of 1882, by successive appropriations and in accordance with modifications made in 1881 of the original project, the improvement had attained a depth of 15 feet in the winding basin and a channel of entrance 15 feet deep, with a width of 90 feet at the outer end and 200 feet near the steamboat landing.

The project was further modified in August, 1882, to provide for a channel depth of 15 feet for the full width of 200 feet, but as yet nothing has been done towards it beyond making a survey of the channel and entering into contract for dredging to the extent of the funds available.

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After the completion of the survey referred to proposals were invited for dredging. These were opened May 31, 1887, and the contract awarded to the Green Bay Dredge and Pile Driver Company, the lowest bidders. Under their contract, dated June 6, 1887, work is to be begun on or before August 1, 1887.

The price at which this dredging is to be done is so low that much more will be accomplished with the available funds than was expected.

The original estimate of the cost of the improvement was $395,000. Since that time private parties have built piers along a considerable portion of the channel bank, and this, together with the fact developed that it is highly probable that for channel purposes no revetment of the bank will be necessary, has caused a revision of the estimates, reducing them about one-half. Should the result prove otherwise, the original estimate will be found none too great.

The amount thus far appropriated for the work, or becoming available from other sources, is $133,016.13, of which a balance of $19,291.20 is available. This will serve, at contract price, to remove about 162,000 cubic yards of material, and will go far towards completing that portion of the project. Hence it is not thought necessary to ask for more than $15,000, with which to continue the improvement.

The commerce of Cheboygan in 1869 is given in detail at page 186, Report of the Chief of Engineers for 1871, and for 1870 at page 175 of the same report. A table is appended giving the entrances and clearances from 1874 to June 30, 1886, both inclusive, as obtained from the custom-house records. From the table it will be observed that the number and tonnage of vessels has steadily increased. These may fairly be taken to represent the rate of increase of the commerce; but it should be borne in mind that the custom-house records do not always afford a fair measure of the traffic, because they are intended for another purpose, and do not necessarily include all the data requisite to show the actual volume of business. In this particular case none of the steamers of the two lines between Detroit, Mackinac, and Saint Ignace are included, because they are neither entered nor cleared at Cheboygan. Yet these steamers average at least one arrival and one departure for every day during the season of navigation, and they carry nine-tenths of all the passengers, together with the greater portion of the freights, not an item of which appears upon the custom-house records of the place.

The work is located in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich., and the nearest light-house stands on the pierhead marking the outer end of the channel.

Money statement.

July 1, 1886, amount available		$4,990.66
Received from sale of fuel		20.63
Amount appropriated by act approved August 5, 1886		15,000.00
		20,011.29
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$716.73	
July 1, 1887, outstanding liabilities	3.36	720.09
July, 1887, amount available		19,291.20
Amount (estimated) required for completion of existing project		85,000
Amount that can be profitably expended in fiscal year ending June 30, 1889		15,000
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

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Abstract of bids for dredging harbor at Cheboygan, Mich., received and opened on May 31 1887, in accordance with advertisement dated April 30, 1887.

No.	Names and addresses of bidders.	Price per cubic yard scow measurement.
		Cents.
*1	The Green Bay Dredge and Pile Driver Company, Green Bay, Wis	11½
2	Carkin, Stickney, & Cram, East Saginaw, Mich	14¾
3	Charles B. Crane, Chicago, Ill	15½
4	Chauncey E. Mitchell, Ludington, Mich	17⅝
5	Arthur H. Williams, Sault St. Marie, Mich	18
6	Buck & Hubbell, Saginaw, Mich	19½
7	William Upham & Co., Duluth, Minn	23
8	Robert Finch, Grand Haven, Mich	23
9	Hubbell & Skeldon, Saginaw, Mich	23½
10	Stang & Gillmore, Lorain, Ohio	24½

* Recommended for acceptance.

Custom-house records, Cheboygan, Mich.

Year.	Entered.					Cleared.					Receipts.
	Steam-vessels.		Schooners and barges.		Total:	Steam-vessels.		Schooners and barges.		Total.	
	No.	*Tons.*	*No.*	*Tons.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*	
1874	62	19,848	85	29,904	47,752	87	30,699	190	48,830	79,529	$1,075.37
1875	74	26,815	254	74,449	101,264	120	46,620	217	71,902	118,522	2,465.70
1876	87	13,824	232	68,284	81,608	40	13,820	225	65,754	79,574	1,687.66
1877	102	38,222	253	75,157	113,379	98	37,586	310	89,024	126,610	2,417.74
1878	124	52,974	236	69,856	122,830	119	51,385	291	106,368	157,753	2,601.08
1879	136	54,690	235	63,878	118,568	126	46,975	258	76,750	123,725	1,687.08
1880	64	59,019	303	84,420	143,439	169	60,100	313	85,771	145,871	3,068.56
1881	261	87,126	411	125,190	212,316	276	105,048	409	121,871	226,919	3,057.91
1882	290	80,171	296	88,832	169,003	318	105,425	285	75,992	181,417	6,519.23
1883	287	50,446	236	73,057	123,503	288	50,966	255	77,555	128,521	2,952.82
1884	317	63,148	200	59,355	122,503	314	65,672	211	63,343	129,015	1,120.73
1885 to June 1886	386	100,059	206	64,292	164,351	391	102,490	222	69,850	172,340	551.93

K K 6.

IMPROVEMENT OF HARBOR AT THUNDER BAY, MICHIGAN.

The project for the improvement of this harbor was adopted in 1876, the object being to obtain an entrance channel from the bay into the river, of navigable width and of not less than 13 feet in depth. The project was subsequently modified to such extent as to provide for a depth of 14 feet.

This had been practically accomplished by mid-summer 1884, and further work was suspended.

The balance available for the work is $4,525.07, which appears to be sufficient for present purposes, in view of the fact that no complaints concerning the channel have been made during the last fiscal year. Estimates for further appropriations are therefore omitted for the present.

This work is located in the collection district of Huron, Mich. The nearest port of entry is Port Huron, Mich., and the nearest light-house is at the work.

Money statement.

July 1, 1886, amount available	$4,525.07
July 1, 1887, amount available	4,525.07

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K K 7.

IMPROVEMENT OF HARBOR AT AU SABLE, MICHIGAN.

The present project for the improvement of this harbor was adopted in 1866 and modified in 1879, the object being to obtain a channel of not less than 10 feet in depth for a width of 100 feet, from the lake to the State Road Bridge at Au Sable. The attempts to improve this harbor have not been as successful as had been hoped. The reasons for this are fully set forth in the Annual Report of 1885 (see pages 2130 *et. seq.*, Annual Report of the Chief of Engineers for 1885).

Since that report was submitted nothing has occurred to cause a modification of the opinion therein expressed—that is to say, that it is not possible to make any permanent improvement of the harbor at a cost commensurate with the advantages to be gained.

No expenditures on account of the work were made during the fiscal year ending June 30, 1887, and no operations are in contemplation. The balance remaining from former appropriations is $4,861.53, and no further appropriation is asked for at this time.

The shipments from this port are quite important, consisting of lumber, lath, salt, etc., but are largely made from private piers built into the lake, entirely outside of the harbor.

The work is located in the collection district of Huron, Mich. The nearest port of entry is Port Huron, and the nearest light-house is at the work.

Money statement.

July 1, 1886, amount available	$4,861.53
July 1, 1887, amount available	4,861.53

K K 8

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

In 1866 the mouth of Saginaw River was obstructed by a bar in Saginaw Bay, about 1 mile from shore, and a half mile across it between the 10-foot curves, with a minimum depth of about 9 feet.

Between the mouth of the river and Bay City, a distance of about 5 miles, the depth varied from 15 to 30 feet. Thence to the head of the river, a distance of 16 miles, the channel was obstructed by a number of bars having only 7 feet of water, thus limiting the navigable depth to about 7 feet, although the prevailing depth varied between 12 and 20 feet.

The original project for the improvement of the river was made in 1866, and contemplated dredging a straight channel across the bar at the mouth, 12 feet deep and 195 feet wide. This was completed in 1869, the length being 6,800 feet.

In 1874 a project for improving the river above Bay City was adopted. It included dredging a 10-foot channel across the bars at East Saginaw and Carrollton and the construction of a pile revetment along one side of the new channel at the latter place. To this were added, in 1876, projects for similar improvements at Zilwaukie Bar and New York Works Bar, and in 1879 at Willow Island. Under these projects work slowly progressed until 1881.

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In 1882 a Board of Engineers considered the subject of the general improvement of Saginaw River, and recommended that the channel be made 200 feet wide and 14 feet deep from Saginaw Bay to Bay City, and 12 feet deep thence to the head of the river, a total distance of about 23 miles.

The details of the project are given at pages 1863 *et seq.* of the Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1883, to which I respectfully refer.

An addition to the project has been made, providing for the repair and extension of the revetment confining the Carrollton Channel, and the construction of similar works at the head of Crow Island for the improvement of Zilwaukie Bar.

Congress has directed that $5,000 of the appropriation of August 5, 1886, shall be expended in improving the west channel along West Bay City. This is also in addition to the project submitted by the Board of Engineers in 1882.

At the beginning of the fiscal year the available funds had been reduced to $47.73, and all operations had ceased.

By the river and harbor act of August 5, 1886, the sum of $33,750 was appropriated for "Continuing improvement, * * * of which sixteen thousand eight hundred and seventy-five dollars are to be used above Bay City, and five thousand dollars in improving the west channel along West Bay City."

Under date of September 21, 1886, a project was submitted for the expenditure of all but the last item of this appropriation, and duly approved.

The project was as follows, viz:

Above Bay City.—Apportionment, $14,875. In five sections, as follows:

I. Repairs of beam-wall at Carrollton.

II. Re-enforcement of beam-wall at same.

III. Repairs of revetment at same.

IV. Extending revetment 1,000 feet down-stream.

V. Dredging at head of Crow Island.

Pile-driving, dredging, furnishing piles, timber, lumber, edgings, and iron materials to be by contract. Some old material already on hand, together with the new materials, to be built into the work by hired labor.

Opposite and below Bay City.—Apportionment, $11,875. Dredging on the bar at the mouth of the river to the extent of the funds available, after deducting what may be necessary for surveys to determine the condition of the dredged channels.

West channel, along West Bay City.—Apportionment, $5,000. This, not being a part of the original project, had never been surveyed, and it was therefore necessary to make a sufficient survey to develop the channel and show what was required. This was done during the month of January, and a project submitted under date of April 11, 1887, which was duly approved.

Contracts dated November 10, 1886, were entered into as follows:

Dredging Saginaw River above Bay City, Carkin, Stickney & Cram.
Furnishing, driving, and pulling piles, Ozro J. Quinn.
Furnishing iron bolts, spikes, and nails, Ducharme, Fletcher & Co.
Dredging on bar at mouth of river, Carkin, Stickney & Cram, Hickler & Green.
Contract dated December 8, 1886, with John G. Owen, for furnishing timber, plank, and edgings.
Contract dated June 21, 1887, with Hubble & Skeldon, for dredging west channel, along West Bay City.

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The work of dredging above Bay City was begun by the contractors, Carkin, Stickney & Cram, on the bar at the head of Crow Island, April 27, 1887, completing the work on the 14th of May. Four thousand six hundred and ninety-eight cubic yards of material were removed, which, at the contract price of 34 cents per cubic yard, amounted to $1,597.32.

Both firms of contractors for dredging on the bar at the mouth of Saginaw River, Carkin, Stickney & Cram and Hickler & Green, failed to begin work on the 1st of May, 1887, the day specified. The first-mentioned firm put one dredge to work on the 23d June, but after removing 1,300 cubic yards of material the dredge broke down on the 29th and was taken away. The work done was to continue for 548 feet the fourth dredge cut east of the axis of the channel. The cost of this at the contract price of 44½ cents per yard was $578.50.

Work was begun May 9, 1887, on the several sections of repair work at Carrollton. Up to and including the last Saturday of June, Ozro J. Quinn, under his contract, had furnished and driven 384 Norway pine piles and had pulled and redriven 28 old piles, all amounting, at contract prices, to $1,142.32. Under his contract John G. Owen furnished and delivered at Carrollton pine timber, pine lumber, and hemlock lumber, amounting, at contract prices, to $470.02.

Ducharme, Fletcher & Co. delivered in November, 1886, the iron bolts, etc., under their contract, amounting to $610.78.

At the end of the fiscal year the work had progressed as follows:

The repairs of the beam-wall (Section I), consisting of the closing of gap 270 feet long, had been completed.

The re-enforcement of the beam-wall (Section II), a length of 2,730 feet, was in progress; 354 piles had been driven in place, of which 154 had been bolted, 136 topped, and 144 peeled. The old binder timbers had been replaced in proper alignment and secured by cap timbers for a length of 264 feet.

The removal of the old superstructure (Section III) had been commenced.

It is proposed during the current fiscal year to complete the dredging contracted for on the bar at the mouth of the river. It is expected that all the repair work at Carrollton will be completed before the close of the present season, as it is hoped will also be the dredging of the west channel, along West Bay City.

Much complaint is made of dangerous snags in the river, consisting principally of saw-logs, which have escaped from booms or rafts. The butts of these, being heavier than the tops, sink in such manner as to make very ugly snags of them. Persons on the river with proper appliances would remove them, taking the logs in full payment, but the owners claim that they have not abandoned the logs and prohibit this disposition of them. Urgent appeals have been made to me to have the snags of all kinds removed at the expense of the appropriations. I have not yet seen my way clear to recommending such an expenditure.

FUTURE OPERATIONS.

In case the condition of available funds at the close of this season's operations is such as to warrant it, ice surveys should be made during the current winter, in order to determine the condition of the several channels where work has been in progress.

The most important part of the original project is the dredging on the bar at the mouth of the river. This once done is not likely to need much of arttention some years, because the material of which the bar is com-

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posed is hard and stands well. A channel excavated through it has, therefore, a good degree of permanence. The amount appropriated should be sufficient to push this far towards completion.

The repairs, re-enforcement, and extension of the pile revetments and beam wall at Carrollton Bar, and the construction of a pile-pier or wing-dam at the head of Zilwaukie Bar, in accordance with my recommendation of the last two years, should be pushed as rapidly as practicable. (See page 2139 Annual Report of the Chief of Engineers for 1885, and page 1827 Annual Report for 1886.) Some progress will have been made by the expenditure of the appropriation of August 5, 1886, but the amount available is so small that we can do but little above Bay City beyond keeping what we have got.

The constructions recommended will tend to reduce the amount required for the annual dredging contemplated in the original project at points where this seems to be necessary, but it is not expected that they will entirely obviate such necessity. Annual dredging of greater or less extent will always be required to maintain the channel.

Notwithstanding the temporary character of the benefits derived from this annual dredging, it should be continued, as giving relief to a commerce of nearly 2,000,000 tons, having a value of $20,000,000.

For convenience in referring to it, I repeat the estimate of the last two years, as follows:

Repairs to revetment at Carrollton	$9,000
Extension of revetment at Carrollton	10,000
Dredging at Carrollton	18,000
Revetment at Crow Island	3,000
Dredging at Crow Island	10,800
Continuing dredging opposite and below Bay City	100,000
Dredging at other places for immediate relief	15,000
Total	165,800
From the foregoing should be deducted the amount appropriated by the act of August 5, 1886, less the $5,000 applied to West Channel along West Bay City	28,750
Remainder to be appropriated	137,050

This amount would be applicable as follows:

Above Bay City	$33,925
Opposite and below Bay City	88,125
For general use on the whole river	15,000
Total	137,050

The Saginaw River improvement is located in the collection district of Huron, Mich. The nearest light-house is at the mouth of the river. The nearest port of entry is at Port Huron, Mich.

Money statement.

July 1, 1886, amount available		$47.73
Received from sale of fuel		6.90
Amount appropriated by act approved August 5, 1886		33,750.00
		33,804.63
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$5,197.49	
July 1, 1887, outstanding liabilities	2,255.02	
		7,452.51
July 1, 1887, amount available		26,352.12

Amount (estimated) required for completion of existing project 337,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 137,050.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Tabulated statement showing the arrivals and clearances from Saginaw River ports from 1880 to 1886, inclusive.

Years.	Arrived.			Cleared.		
	Steam-vessels.	Sail-vessels.	Tonnage.	Steam-vessels.	Sail-vessels.	Tonnage.
1880	442	1,652	643,997	453	1,671	671,951
1881	527	1,867	796,220	542	1,832	786,311
1882	552	1,703	785,529	568	1,793	784,234
1883	498	1,515	627,628	511	1,551	624,742
1884	505	1,447	605,227	534	1,487	619,981
1885	424	1,289	529,049	442	1,295	554,823
1886	414	1,088	463,895	421	1,371	493,691
Total	3,362	10,561	4,453,545	3,471	11,000	4,535,732

Table showing the principal products and business done on Saginaw River during the season of 1886.

Products.	Saginaw (upper river).	Bay City, etc. (lower river).	Total.
Pine lumber.....feet, B. M.	374,964,909	409,956,315	784,921,224
Hard wood lumber.....do	6,280,000	7,625,000	13,905,000
Shingles.....pieces	166,213,000	61,250,000	227,463,000
Lath.....do	39,665,300	60,454,100	100,119,400
Staves, for salt barrels	23,053,338	13,182,427	36,235,765
Headings for salt barrels.....sets	1,684,022	1,270,475	2,954,497
Lumber, shipped by water.....feet, B. M.	173,784,000	417,279,100	591,013,100
Shingles, shipped by water.....pieces	42,038,000	75,456,000	117,494,000
Lath, shipped by water.....do	14,686,000	18,467,000	33,153,000
Logs, brought by water.....feet, B. M.	.....	.....	586,440,923
Logs, brought by railroads.....do	.....	.....	149,555,557
Salt manufacturing firms	52	31	83
Salt, barrels of inspected	1,213,811	907,384	2,121,195

Abstract of bids for improving Saginaw River, Michigan, received and opened October 29, 1886, in accordance with advertisement dated October 9, 1886.

No.	Names and addresses of bidders.	Dredging Saginaw River above Bay City, per cubic yard, scow measure.	Dredging bar at mouth of Saginaw River, per cubic yard, scow measure.
		Cents.	*Cents.*
1	Carkin, Stickney & Cram, East Saginaw, Mich	*34	†44½
2	Hickler & Green, Sault de St. Marie, Mich	.....	†44½
3	Buck & Hubbell, Saginaw City, Mich	40	52
4	James Rooney, Toledo, Ohio	44½	61¼
5	L. P. & J. A. Smith, Cleveland, Ohio	60	50
6	George Talbot, Buffalo, N. Y	60	50
7	Stang & Gillmore, Lorain, Ohio	61	51

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Abstract of bids for improving Saginaw River, Michigan, etc.—Continued.

No.	Names and addresses of bidders.	Piles and pile driving.				Timber, plank, and edgings.				
		Black ash piles, per linear foot.	Norway pine piles, per linear foot.	Driving new piles, each.	Pulling and redriving old piles, each.	White pine timber, 122,128 feet, B. M., per M feet, B. M.	White pine plank, 20,000 feet, B. M., per M feet, B. M.	Hemlock planks, 59,200 feet, B. M., per M feet, B. M.	Mill edgings, 1,500 cords, per cord.	Approximate total.
		Cents.	*Cents.*							
8	Osro J. Quinn, East Saginaw Mich*	4½	6	$0.33	$1.33	.....	.....	.....	.....	.....
9	Thos. B. Cresswell, East Saginaw, Mich‡	5	6½	.99	1.98	$20.75	.....	$11.50	$1.70	.....
10	Buck & Hubbell, Saginaw City, Mich	5½	6	1.09	3.25	.....	.....	.....	.....	.....
11	Carkin, Stickney & Cram, East Saginaw, Mich	.....	6½	1.00	2.00	25.00	.....	15.00	.....	.....
12	Luther E. Allen, Charlevoix, Mich	14	14	1.90	2.50	.....	.....	.....	.....	.....
13	John G. Owen, East Saginaw, Mich	.....	.....	.....	.....	19.75	$13.00	9.50	3.25	$6,129.17

No.	Names and addresses of bidders.	Iron bolts, spikes, and nails.				
		Screw-bolts, 9,000 pounds, per pound.	Drift-bolts, 11,500 pounds, per pound.	Spikes, 3,300 pounds, per pound.	Nails, 600 pounds, per pound.	Approximate total.
		Cents.	*Cents.*	*Cents.*	*Cents.*	
11	Carkin, Stickney & Cram, East Saginaw, Mich	5	3	3	2.75	$910.50
14	Ducharme, Fletcher & Co., Detroit, Mich*	2.55	2.13	2.65	2.10	601.50
15	Morley Brothers, East Saginaw, Mich	2.75	2.25	2.80	2.25	612.15
16	Mark Packard, Buffalo, N. Y	3.65	3	2.75	3	661.25

* Recommended for acceptance. † To be divided between the two bidders.
‡ The bid of Thos. B. Cresswell was received in the same envelope as that of Morley Bros.

Abstract of bids for furnishing timber, plank, and edgings for use in repairing Carrollton revetment and beam wall, Saginaw River, Michigan, received and opened December 1, 1886, *in accordance with advertisement dated November* 16, 1886.

Articles.	*1. John G. Owen, East Saginaw, Mich.	2. Carkin, Stickney & Cram, East Saginaw, Mich.
White pine timber, 122,128 feet, B. M., per 1,000 feet, B. M	$19.25	$20.00
White pine plank, 20,000 feet, B. M., per 1,000 feet, B. M	12.75	15.00
Hemlock plank, 59,200 feet, B. M., per 1,000 feet, B. M	9.25	12.00
Mill edgings, 1,500 cords, per cord	2.00	2.00
Approximate total	6,172.80	6,472.40

* Recommended for acceptance.

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Abstract of bids for dredging west channel of Saginaw River, along West Bay City, Mich., received and opened June 2, 1887, in accordance with advertisement dated May 3, 1887.

No.	Names and addresses of bidders.	Price per cubic yard, scow measure.
		Cents.
*1	Hubbell & Skeldon, Saginaw, Mich	30
2	Carkin, Stickney & Cram, East Saginaw, Mich	37½

* Recommended for acceptance.

K K 9.

IMPROVEMENT OF HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

The present project for this harbor was adopted in 1873. It consists of a breakwater constructed of timber cribs filled with stone, inclosing an area which is to be deepened by dredging where necessary. Its object is to afford a harbor of refuge to vessels engaged in the navigation of the northern and northwestern lakes when caught in heavy weather near the dangerous Point aux Barques, the southerly headland of the mouth of Saginaw Bay.

Prior to 1876 vessels so caught were compelled to run a distance of 60 miles and find a refuge in St. Clair River. After the subsidence of the gale those upward-bound had to work their way back again. Few improvements have resulted in greater benefit to the lake commerce, as is fully shown by the infrequency of disasters in the vicinity since it became available.

No contracts were in force at the beginning of the fiscal year, and between July 1, and August 9, 1886, the work of construction was suspended for want of funds. During this interval detail plans and bills of material were prepared for continuing repairs to the main pier. These covered repairs to the cribs and renewing the break in the main pier reported last year, as well as the repairs of the superstructure walls where torn out by the storm of December 4 and 5, 1885, and where badly decayed, between the break and the north entrance; the renewal of the decking, and the rebuilding of the sea-wall from the north entrance to the break upon a plan designed to remedy some of the defects developed in the construction of the former sea-wall.

Work was resumed on this project August 9, 1886. Contracts were made with Henry Howard & Co. for timber and plank, and with Ducharme, Fletcher & Co. for iron work. The ballast stone required were purchased in open market from all-comers at a fixed price, and the work was done by hired labor.

The contract with Henry Howard and Co. was filled and closed October 29, 1886, and that with Ducharme, Fletcher & Co. November 23. The work under the project was completed November 8, and the work of construction closed November 10.

The work done during the season of 1886 left the main pier, for a distance of 770 feet south of the north entrance, with the superstructure

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walls repaired and the cribs refilled with stone; the decking renewed and protected by a new sea-wall. Continuing south a distance of 300 feet the superstructure walls were rebuilt across the break and filled with stone.

For 200 feet the damaged cribs were rebuilt from a level from 4 to 7 feet under water to the water-surface, and the new superstructure carried over them.

The entire length of 300 feet was decked over on the inside and middle pockets, the outside pockets being left open to receive the sea-wall posts and braces.

A severe storm from the southeast on November 17 tore away some additional timbers from the already damaged south pier. The work sustained no other damage from the fall and winter storms.

By the river and harbor act of August 5, 1886, the sum of $75,000 was appropriated for "continuing improvement," * * * "of which not exceeding $45,000 are to be used in repairs."

During the winter plans and bills of materials were prepared for continuing the repairs and the work of construction. Contracts dated March 17, 1887, were entered into with Brooks Joslyn & Co. for timber; with Ducharme, Fletcher & Co., for iron; and with McNellis & Johnson for ballast stone.

The failure of the river and harbor bill at the session of Congress ending March 4, 1887, rendered necessary a modification of the project for the season's work, to the extent of omitting the proposed dredging in the harbor and the construction of the superstructure on the south pier.

The first boat of the season arrived at the harbor on April 20, 1887, and the work of construction was resumed on the 1st of May. It has continued to the close of the fiscal year without interruption, being confined to the main pier. The outside face, where built across the break of December 4 and 5, 1885, was prepared by the diver and carpenters for receiving the wainscoting and plating, which was then put in place and bolted. The outside wall of the superstructure has been shimmed up to full height for a length of 2,500 feet south of the break of 1885, and new ties added where needed. A new sea-wall has been built from the north side of the break of 1885 southward for 1,400 feet, and an additional length of 1,000 feet built up but not finished. The entire length has been filled with stone.

The contract of Ducharme, Fletcher & Co. for iron was completed and closed May 12. The other contracts extend into the fiscal year 1887-'88.

The work proposed for the remainder of the season, covering a portion of sea-wall, repairs to the main pier, and some protection work and repairs to the south pier, will exhaust the available funds.

The next appropriation should be expended in completing the repairs to the main pier, repairing the deck of the west pier, dredging inside the harbor, and building a superstructure upon the unfinished south pier.

The following is an estimate of the cost of this project, viz:

Completing the repairs to the main pier	$10,000
Repairing the decking of the west pier	5,000
Dredging	15,000
Beginning the construction of a permanent superstructure on south pier	100,000
Total	130,000

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The original estimate of the cost of the work was	$1,442,500
Amount heretofore appropriated	1,050 000
Difference	392,500
To this should be added the expenditures on account of operating the harbor, and for repairs rendered necessary by extraordinary circumstances, such as storms, decay of the earlier portion of the work (the appropriations not having been sufficient to complete it before such have occurred), etc., none of which formed any part of the original estimate, estimated at	75,000
Total difference	467,500
Estimated amount required to complete the original project	100,000
Actual cost of construction less than estimated	367,500

This harbor has but little local importance, but is of great value to the general commerce of the lakes. The extent to which it is utilized by this commerce is shown by the following tables.

One thousand two hundred and eighty-three vessels, with an aggregate of 361,189 tons register, sought refuge in the harbor during the year.

Money statement.

July 1, 1886, amount available		$4,283.60
Repayment of disallowance		16.47
Amount appropriated by act approved August 5, 1886		75,000.00
		79,300.07
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$34,277.72	
July 1, 1887, outstanding liabilities	9,446.75	
		43,724.47
July 1, 1887, amount available		35,575.60
Amount (estimated) required for completion of existing project		130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		130,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for furnishing timber and plank and iron plates, bolts, and spikes for repairing crib-work at the harbor of refuge at Sand Beach, Michigan, received and opened on September 11, 1886, *in accordance with advertisement dated August* 27, 1886.

No.	Names and addresses of bidders.	White pine timber and plank, per M feet, B. M.	White oak timber, per M feet, B. M.	Iron plates per pound.	Blunt bolts per pound.	Pointed bolts per pound.	Boat spikes per pound.
				Cents.	*Cents.*	*Cents.*	*Cents.*
*1	Henry Howard & Co., Port Huron, Mich	$18.00	$30.00	.....	.....	.....	.....
2	Brooks & Joslyn, Port Huron, Mich	19.00	30.00	.....	.....	.....	.....
3	Carkin, Stickney & Cram, East Saginaw, Mich	22.50	40.00	5	5	5	5
*1	Ducharme, Fletcher & Co., Detroit, Mich	.....	.....	2.85	2.20	2.45	2.60

* Recommended for acceptance.

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Abstract of bids for furnishing hardware and ship chandlery for improving harbor of refuge, Lake Huron, Michigan, received and opened on September 17, 1886, in accordance with advertisement dated September 7, 1886.

No.	Names and addresses of bidden	Hardware.	Ship chandlery.
*1	T. B. Rayl & Co , Detroit, Mich	$34.42	.....
2	Jas. L. Fisher, Detroit, Mich	38.72	.....
3	J. Jenks & Co., Sand Beach, Mich	39.73	.....
*1	George W. Edwards, Detroit, Mich	.....	$23.25

* Recommended for acceptance.

Abstract of bids for furnishing timber and plank and iron bolts and spikes and stone for crib-work at the harbor of refuge at Sand Beach, Michigan, received and opened March 10, 1887, in accordance with advertisement dated February 8, 1887.

No.	Names and addresses of bidders.	White pine timber and plank (643,150 feet, B. M.), per M feet, B. M.	White oak plank (28 400 feet, B. M.), per M feet, B. M.
1	Brooks, Joslyn & Co., Port Huron, Mich	$21.50	$30.00
2	Henry Howard & Co., Port Huron, Mich	22.00	30.00
3	Carkin, Stickney & Cram, East Saginaw, Mich	23.50	21.00

No.	Names and addresses of bidders.	Blunt bolts (41,865 pounds), per pound.	Pointed bolts (23,032 pounds), per pound.	Boat spikes (18,935 pounds), per pound.	Ladder irons (976 pounds), per pound.
		Cents.	*Cents.*	*Cents.*	*Cents.*
1	Ducharme, Fletcher & Co., Detroit, Mich	2.54	2.75	*2.87 †2.96	2.80
2	Mark Packard, Buffalo, N. Y	2.99	2.99	2 99	2.50
3	Carkin, Stickney & Cram, East Saginaw, Mich	3.75	3.75	3½	.....

No.	Names and addresses of bidders.	Stone. (1,500 cords), per cord.	Approximate total.
1	Brooks, Joslyn & Co., Port Huron, Mich	.....	‡$14,679.72
2	Henry Howard & Co., Port Huron, Mich	.....	15,000.30
3	Carkin, Stickney & Cram, East Saginaw, Mich	.....	15,710.42
1	Ducharme, Fletcher & Co., Detroit, Mich	.....	‡2,199.38
2	Mark Packard, Buffalo, N. Y	.....	2,441.28
3	Carkin, Stickney & Cram, East Saginaw, Mich	.....	§3,090.47
1	McNellis & Johnson, Port Hope, Mich	$4.80	‡7,200.00
2	George W. Jenks, Sand Beach, Mich	5.97	8,955.00
3	Carkin, Stickney & Cram, East Saginaw, Mich	10.00	15,000.00

* For ½ inch.
† For ⅝ inch.
‡ Recommended for acceptance.
§ No separate price for ladder irons, included and figured at the rate of pointed bolts.

Abstract of bids for furnishing supplies for improving harbor of refuge, Lake Huron, Michigan, received and opened March 15, 1887, in accordance with advertisement dated February 23, 1887.

No.	Names and addresses of bidders.	Supplies.	Amount.
*1	J. Jenks & Co., Sand Beach, Mich	Hardware	$162.65
2	Hodgson & Howard, Detroit, Mich	....do	179.96
3	T. B. Rayl & Co., Detroit, Mich	....do	181.07
*1	H. D. Edwards & Co., Detroit, Mich	Ship chandlery	278.70
†2	The J. P. Donaldson Co., Detroit, Mich	....do	313.79
*1	George W. Jenks, Sand Beach, Mich	Lump coal	375.00

* Recommended for acceptance. † Bids not signed.

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No. 1.—*Record of vessels taking refuge in the harbor of refuge, Lake Huron, Michigan, from June 30, 1886, to June 30, 1887.*

Direction of the wind at time of entering.	1886.						1887.			Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	April.	May.	June.	
North:										
Steam	5	11	2	16	4	.....	5	6	5	54
Sail	10	7	7	8	1	.....	2	12	5	52
Tow	3	10	4	20	1	.....	4	2	.....	44
										150
Northwest:										
Steam	2	23	44	29	28	.....	.....	1	3	130
Sail	1	8	6	6	20	.....	.....	.....	1	42
Tow	4	33	36	12	11	.....	.....	1	.....	97
										269
West:										
Steam	1	4	20	16	33	7	6	.....	1	88
Sail	5	4	16	5	19	2	1	.....	4	56
Tow	1	3	28	17	23	4	4	.....	.....	80
										224
Southwest:										
Steam	5	1	10	12	61	2	1	5	6	103
Sail	8	1	13	20	18	.....	.....	11	5	76
Tow	.....	.....	4	3	47	.....	.....	3	.....	57
										236
South:										
Steam	3	2	1	9	4	.....	1	.....	.....	20
Sail	2	5	1	8	5	.....	.....	.....	.....	21
Tow	2	1	.....	6	4	.....	.....	.....	.....	13
										54
Southeast:										
Steam	4	10	34	6	8	.....	4	8	15	89
Sail	.....	14	27	9	3	.....	2	22	17	94
Tow	3	3	18	2	2	.....	1	.....	12	41
										224
East:										
Steam	.....	.....	.....	1	2	.....	.....	.....	1	4
Sail	1	1	.....	.....	1	.....	.....	.....	.....	3
Tow	.....	.....	.....	.....	4	.....	.....	.....	.....	4
										11
Northeast:										
Steam	6	9	4	11	3	.....	.....	6	7	46
Sail	15	5	6	2	.....	.....	.....	3	5	36
Tow	3	3	5	15	3	.....	.....	.....	2	33
										115
Monthly total:										
Steam	26	60	115	100	143	9	17	26	38	534
Sail	42	45	76	58	67	2	5	48	37	380
Tow	18	53	95	75	95	4	9	6	14	369
Total	86	158	286	233	305	15	31	80	89	1,283

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No. 2.—*Classified table of tonnage, by months, entering the harbor of refuge, Sand Beach, Lake Huron, for shelter from June 30, 1886, to June 30, 1887.*

Months.	Steamer.		Sail.		Tow.		Total.	
1886.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
July	26	5,970	42	3,457	18	6,491	86	15,918
August	60	15,458	45	2,817	53	14,585	158	32,860
September	115	32,870	76	6,878	95	33,531	286	73,279
October	100	43,831	58	5,285	75	28,721	233	77,837
November	148	67,915	67	9,077	95	34,868	305	111,860
December	9	4,999	2	90	4	2,368	15	7,457
1887.								
April	17	5,443	5	946	9	3,910	31	10,299
May	26	8,164	48	3,086	6	2,500	80	13,750
June	38	10,956	37	1,724	14	5,250	89	17,930
Total	534	195,606	380	33,360	369	132,224	1,283	361,190

No. 3.—*Tonnage of vessels taking shelter in the harbor of refuge, Sand Beach, Lake Huron.*

Calendar year.	Tonnage.			Total tonnage.	Total number of vessels.	Average tonnage.
	Steam.	Sail.	Towed.			
1877	63,966	27,699	50,954	142,619	493	289
1878	104,025	39,699	99,282	243,006	781	311
1879	133,080	45,750	100,096	278,926	921	303
1880	158,720	55,630	147,260	361,592	1,317	275
1881	144,645	55,960	127,855	328,460	1,176	279
1882	146,132	26,504	114,067	286,703	1,022	280
1883	177,122	32,713	114,091	323,926	1,139	284
1884	156,518	34,724	122,980	314,222	1,142	275
1885	196,364	29,426	151,607	377,397	1,158	325
1886	196,335	33,790	140,862	370,987	1,304	284
Total	1,476,889	381,895	1,169,054	3,027,838	10,453	290

K K 10.

STEAM LAUNCH OR TUG FOR HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

The steam-launch reported in the last annual report as constructing by Mr. David Bell, of Buffalo, N. Y., under contract dated April 5, 1886, was completed and delivered at Sand Beach as required. The boat has been in satisfactory use since delivery.

The amount of the appropriation was $10,000. The entire expenditure was $5,901.14. Hence the sum of $4,098.86 remains in the Treasury unexpended.

Money statement.

July 1, 1886, amount available	$9,661.06
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	5,562.20
July 1, 1887, amount available	4,098.86

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K K 11.

IMPROVEMENT OF ICE-HARBOR OF REFUGE AT BELLE RIVER, MICHIGAN.

The project for this improvement was adopted in 1880, the object being to obtain a channel 50 feet wide, 13 feet deep to the first bridge, 12 feet thence to the second bridge, and affording a safe harbor against running ice.

The work was completed in 1885, according to the project, and gives satisfaction.

Nothing further is required at this time, and therefore no estimate is submitted.

Belle River is in the collection district of Huron, Mich. The nearest light-house is at St. Clair Flats Canal.

Money statement.

July 1, 1886, amount available	$47.10
July 1, 1887, amount available	47.10

K K 12.

IMPROVEMENT OF ST. CLAIR FLATS CANAL, MICHIGAN.

This canal was projected in 1866 with a view to obtaining a straight channel 13 feet deep and 300 feet wide across St. Clair Flats, the channel being bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet.

These dikes consist of timber cribs resting upon piles driven into the original bottom of the shoal, the crib pockets being filled with material dredged from the channel.

To maintain a channel-bank a single row of sheet-piling was driven along the channel-face of the cribs previous to dredging.

The lake sides of the dikes were protected from wave action by shorter sheet-piling.

In 1873 the channel was deepened to 16 feet by dredging for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all, being thus limited by the fact that the sheet-piling intended for a depth of 13 feet have not sufficient penetration to admit of dredging to 16 feet for the full width of 300 feet.

The single row of sheet-piling is also insufficient to prevent the leakage of the dike material through it into the channel, and it is necessary to re-enforce it with a double row, giving them, however, sufficient penetration to admit of subsequent dredging to a depth of 20 feet.

The entire timber structure is much decayed, and should be renewed as soon as possible. Its condition has been duly reported in the Annual Reports for the last four or five years, and there is now nothing to add except that the condition becomes worse with each succeeding year. It has now been in place for an average of about nineteen years.

By the river and harbor act of August 5, 1886, the sum of $18,750 was appropriated for continuing the improvement.

Under date of November 15, 1886, a general project was submitted

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for improving the canal and a special project for the application of this appropriation.

The general project contemplates driving a double row of sheet-piling to a depth of 26 feet along the channel-face of each dike, dredging the area between them to a depth of 20 feet, continuing the channel above and below the canal to the same depth in river and lake, and rebuilding the wooden superstructure.

The special project aims at completing as much of the sheet-piling as the available funds will permit.

These projects were based upon data contained in the Annual Report of 1885, in which the cost was estimated at $153,289. I am inclined to think that this estimate, sufficient at the time, is now too small, for the reason that the price of timber and lumber, as well as of labor, is increasing so rapidly that estimates made three or four years ago must be materially increased, and for the additional reason that the sheet-piling now used is one-third thicker than that originally proposed. Hence I do not think it safe to estimate the cost of building the new revetment and renewing the old superstructure at less than $200,000, and if any considerable delay occurs the estimate will have to be further increased. In my opinion the foregoing estimate will not hold good for more than two years. It is exclusive of the cost of deepening the channel by dredging.

The foregoing projects having been duly approved, proposals were invited by public advertisement for so much of the sheet-piling as the available funds would pay for. They were opened December 30, 1886, and the contract awarded to Augustus J. Dupius, the work to begin on or before June 1, 1887, and to be completed on or before December 1, 1887. Contract dated January 7, 1887.

The contractor promptly began operations at the lower end of the eastern dike, when it was discovered that this end of the dike had sunk about 10 inches, and it was deemed necessary to place a new waling piece on the channel-face of the old sheet-piling to level it up and give a proper support to the new work. It was then too late to advertise for proposals therefor, and as Mr. Dupius offered to do the work at a very reasonable price (36 cents per running foot for the completed work) he was instructed to do it.

The work is now in full progress, but at the end of the fiscal year none had been finished to such degree as to entitle the contractor to any payment under the articles of agreement, which provide that payment shall only be made for completed work.

The great importance of this improvement is so well known, its use is so advantageous to a commerce hailing from every lake-port, both in the United States and Canada, amounting to nearly 20,000,000 tons, and nearly, if not quite, equal to our entire foreign commerce by salt-water, that no additional representation seems to be necessary to secure favorable consideration.

The necessity for the work is immediate and urgent. I therefore recommend that the sum of $100,000 be made available for the fiscal year ending June 30, 1889.

Estimated cost of present project, exclusive of dredging	$200,000
Amount appropriated by act of August 5, 1886	18,750
Estimated amount yet to be appropriated	181,250

St. Clair Flats Canal is in the collection district of Detroit, Mich., which is the nearest port of entry. Two light-houses stand upon its banks.

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Money statement.

Amount appropriated by act approved August 5, 1886	$18,750.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	196.06
July 1, 1887, amount available	18,553,94
Amount (estimated) required for completion of existing project	181,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of bids for revetment construction at St. Clair Ship-Canal, Michigan, received and opened on December 30, 1886, in accordance with advertisement dated November 30, 1886.

No.	Names and addresses of bidders.	Price per running foot.
*1	Augustus J. Dupius, Detroit, Mich	$6.87
2	Candler Brothers, Detroit, Mich	7.85
3	Schwarz & Berner, Green Bay, Wis	8.12
4	Stang & Gillmore, Lorain, Ohio	9.85
5	Luther E. Allen, Charlevoix, Mich	9.86
6	R. J. Cram, Detroit, Mich	10.00
7	Henry M. Youmans, East Saginaw, Mich	12.00
8	Hubbell & Skeldon, Detroit, Mich	14.50

* Recommended for acceptance.

K K 13.

OPERATING AND CARE OF ST. CLAIR FLATS CANAL, MICHIGAN.

The sum of $319.53 was expended during the fiscal year in the minor repairs involved in operating and care of the canal. This was due, as has been the case in the past two years, to the fact that the stage of water was such that but few vessels grounded in the canal, and slight damage was done to the dikes. Cavities in the dikes were filled with cedar bark, and the willows growing on the dikes were trimmed as usual, and the cuttings, tied in bundles, also deposited in cavities.

The canal has been in charge of a custodian, who also acts as an inspector when any work is being done in connection with the canal.

The estimated cost of operating and care of the canal for the fiscal year ending June 30, 1888, is as follows:

Salary of custodian	$1,500
Current repairs which can neither be foreseen nor estimated for in detail, to include a fair proportion of the expenses of the superintending engineer at Detroit	3,500
	5,000

all of which is provided for by indefinite appropriation (section 4 of the river and harbor act of July 5, 1884).

Money statement.

July 1, 1886, amount available	$5,000.00
July 1, 1887, amount expended during fiscal year	1,819.53
Amount available by allotment for fiscal year ending June 30, 1888	5,000.00

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Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, as applied to operating and care of St. Clair Flats Canal, Michigan, for the fiscal year ending June 30, 1887.

Date.	No. of voucher.	Object of expenditure.	Amount.
		July.	
1886.			
July 8	1	N. Eisenlord, secretary and treasurer The Detroit Free Press Company, advertising proposals for cedar bark	$5.28
31	2	W. H. Mott, services as custodian, July, 1886	125.00
		August.	
31	1	Hubert Brossard, 80 cords cedar bark, at $1.69	135.20
Aug. 31	2	W. H. Mott, services as custodian, August, 1886	125.00
		September.	
Sept. 30	1	W. H. Mott, services as custodian, September, 1886	125.00
		November.	
Oct. 31	1	W. H. Mott, services as custodian, October, 1886	125.00
31	2	Pay-roll, October, 1886, 2 laborers, 3½ days, at $2	7.00
Nov. 30	3	W. H. Mott, services as custodian, November, 1886	125.00
		December.	
Dec. 31	1	W. H. Mott, services as custodian, December, 1886	125.00
		January.	
1887.			
Jan. 31	.....	W. H. Mott, services as custodian, January, 1887	125.00
		February.	
Feb. 28	1	W. H. Mott, services as custodian, February, 1887	125.00
		March.	
Mar. 31	1	W. H. Mott, services as custodian, March, 1887	125.00
		April.	
Apr. 25	1	H. D. Edwards & Co., 25 pounds lath yarn, at 10 cents	2.50
30	2	W. H. Mott, services as custodian, month April, 1887	125.00
		May.	
May 4	1	Pay-roll, April, 6 laborers, 30 days, at $2	60.00
10	2	H. D. Edwards & Co., 20 pounds lath yarn delivered at St. Clair Flats Canal, at 11¼ cents	2.25
17	3	Pay-roll, May, 6 laborers, 47 days, at $2	94.00
26	4	H. D. Edwards & Co.:	
		1 pair ash oars, 16 feet, at 7 cents	1.12
		1 pair rowlocks	50
31	5	W. H. Mott, services as custodian, May, 1887	125.00
		June.	
June 18	1	C. J. Dowswell & Co.:	
		Pine lumber delivered at St. Clair Flats Canal, 664 feet, B. M	11.20
		Nails, 15 pounds	48
30	2	W. H. Mott, services as custodian, June, 1887	125.00
			1,819.53

K K 14.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

In 1870 the channel over the bar at the entrance to this river afforded a depth of only 3½ feet, whilst the depth in the river some distance above the bar was 10 feet.

The present project for improvement was adopted in 1870 and modified in 1880. It aims to obtain an entrance channel of 8 feet.

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In a report submitted January 23, 1885, a further modification of the project was proposed. This involved straightening the channel of the river at Shoemaker's Bend and minor improvements elsewhere. The full report is printed at page 2190 *et. seq.* of the Annual Report of the Chief of Engineers for 1885, to which I respectfully refer for details.

To straighten the channel at Shoemaker's Bend involves the necessity of dredging across a point of land, and title to the requisite right of way must be obtained.

The city of Mount Clemens, with this in view, has purchased the whole of the land included in the bend, and is willing to give title to the right of way for a nominal sum. I respectfully recommend that the requisite authority of Congress for the purchase be granted, the purchase-money, in amount not exceeding $100, to be paid from the appropriation applicable to the improvement.

By act of August 5, 1886, the sum of $6,000 was appropriated for this improvement, but none of it has yet been expended for the reason that the amount is too small to accomplish anything at the mouth of the river, and the work at Shoemaker's Bend must await the authority of law to purchase right of way.

The estimate of cost of the proposed improvement is $32,926, of which the sum of $6,000 has been appropriated by act of August 5, 1886. If the work is to go on I earnestly recommend that the entire balance ($26,926) be appropriated in one sum.

The latest available statistics of the commerce of Clinton River are those for 1884. They show for that year 141 entrances and 141 clearances, with a total tonnage of 14,526 tons.

The work is situated in the collection district of Detroit, Mich., which is the nearest port of entry. The nearest light-house is the beacon at St. Clair Flats.

Money statement.

Amount appropriated by act approved August 5, 1886	$6,000.00
July 1, 1887, amount available	6,000.00
Amount (estimated) required for completion of existing project	26,926.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	26,926.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

K K 15.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN.

Originally the channel at Lime Kiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depths being much affected by the direction and force of the wind.

As originally projected in 1874, the improvement at this point was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the original estimate was based upon this project.

In 1883 it was wisely determined to so modify the project as to secure a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done.

In 1886 this was further modified, to the end that the width of the channel should be increased to 400 feet, by removing an additional 100 feet from the western (American) side.

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Operations progressed day and night during the fiscal year whenever the season would permit. Two contracts have been in force—

First. With Carkin, Stickney & Cram, dated August 29, 1884. This was closed November 30, 1886, by the exhaustion of the funds applicable thereto.

The following is a statement of the amount of work done under this contract:

Area drilled and blasted and completed	square feet..	369,233
Solid rock removed	cubic yards..	33,265
Loose rock removed	do....	116

These figures illustrate the economy of doing such work under large appropriations (in this case $200,000), as the prices were surely 20 per cent. lower than they had before been under smaller appropriations.

Second. With Dunbar & Sullivan, dated October 15, 1886.

Under this contract drilling and blasting commenced October 18 and continued until December 3, 1886, when work was stopped by the formation of ice in the river.

Operations were resumed March 9, 1887, and by May 23 the drilling and redrilling had been completed over as great an area as the funds available would suffice to pay for. By June 27 the dredging had been completed, and it is expected that by the 1st September, 1887, the "cleaning up" will be finished and the contract closed.

The following is the amount of work done under this contract, viz:

Area drilled, blasted, and completed	square feet..	50,500
Solid rock removed	cubic yards..	4,798
Loose rock removed	do....	109

The total amount of work done during the fiscal year under both contracts was—

Area drilled, blasted, and completed	square feet..	154,061
Solid rock removed	cubic yards..	14,554
Loose rock removed	do....	144

And the total amount of work done on the improvement to June 30, 1887, was—

Area drilled, blasted, and completed	square feet..	883,853
Solid rock removed:		
Under scow measurement	cubic yards..	2,632
Under bank measurement	do....	77,321
Loose rock removed	do....	1,042

Under the existing contract it is estimated that 1,085 cubic yards of rock will be removed between the end of the fiscal year and the closing of the contract, about September 1, 1887.

In addition to the solid rock removed from within the area reported above, 90 cubic yards were removed from a very dangerous shoal about 500 yards below.

In order to complete this important improvement upon the present project, a further quantity of solid rock must be removed, estimated at 14,465 cubic yards.

Herewith is transmitted a tracing showing the original condition of the obstruction and the extent of the improvement.

It is to be understood that there is now a clear channel 300 feet wide and 20 feet deep through the obstruction; that an additional width of 50 feet is far advanced towards completion, and that the removal of 14,465 cubic yards (estimated) will complete it to a width of 400 feet.

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The original estimate of the probable cost of the work was	$1,166,500
Estimated addition, on account of the modification of 1883	40,000
Estimated cost of the additional width of 100 feet (project of 1886)	168,000
Total estimate for present project	1,374,500
Amount heretofore appropriated, which has completed the project as modified in 1883, and, in addition, nearly 50 feet of the project of 1886	572,500
Estimated cost of removing the remainder required to complete the present project	130,500
Actual cost of present project	703,000
Actual cost of present project (400-foot channel) less than the estimate	671,500

It will be seen from the foregoing that the actual cost of the wider and much better channel will be $466,500 less than the orginal estimate for the narrower curved channel proposed in 1874, and for which the first appropriations were made.

This fact encourages me to recommend, in the strongest terms I may properly use, the appropriation in one sum of the $130,500 required to complete the improvement. With such energetic and intelligent contractors as we have been so fortunate as to get on this work in the last few years the whole can be done in one year.

The prospective advantages to commerce from the completion of the improvement, and which are in great degree realized by what has already been done, become apparent from the fact that for many years prior to last season the loss to vessels from detention and damage by striking averaged $100,000 per year, and deep-draught vessels were compelled to move with lighter loads than they could otherwise have carried.

The improvement benefits no local interest. It is truly national in its character. Not a grain of wheat brought from Minnesota or Dakota to New York or a pound of iron ore to Ohio or Pennsylvania but shares its advantages.

This work is located in the collection district of Detroit, Mich.
The nearest port of entry is Detroit.
The nearest light-house is Mammy Judy, about 5 miles distant.

Money statement.

July 1, 1886, amount available		$59,345.30
Received from sale of fuel	$20.63	
Repayment of disallowance	2.00	
		22.63
Amount appropriated by act approved August 5, 1886		37,500.00
		96,867.93
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	81,574.16	
July 1, 1887, outstanding liabilities	6,302.50	
		87,876.65
July 1, 1887, amount available		8,991.27
Amount (estimated) required for completion of existing project		130,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		130,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

WATER-LEVEL OBSERVATIONS.

Herewith is transmitted a tracing upon which is indicated the monthly curve of highest water, that of lowest water, and that of the mean stage, during such time as operations were in progress.

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Abstract of bids for removing solid rock and bowlders from the channel of Detroit River at Lime Kiln Crossing, received and opened on October 7, 1886, in accordance with advertisement dated September 7, 1886.

No.	Names and addresses of bidders.	Solid rock per cubic yard in place.	Loose rock per cubic yard in scow.
*1	Dunbar & Sullivan, Buffalo, N. Y	$6.00	$1.00
2	Carkin, Stickney & Cram, East Saginaw, Mich	6.40	2.50
3	Hickler & Green, Sault Ste. Marie, Mich	6.55	1.00

* Recommended for acceptance.

COMMERCIAL STATISTICS.

The following statistics relating to the commerce of the United States passing the location of this work are submitted as of value in measuring the value of the improvement. The Canadian commerce would considerably increase the figures given below, but is not included because the requisite data are not at hand.

Number and tonnage of United States vessels which passed through Detroit River by seasons, beginning with that of 1880.

Season.	Number of vessels.	Tonnage.	Season.	Number of vessels.	Tonnage.
1880	40,521	20,235,249	1884	38,742	18,045,949
1881	35,888	17,572,240	1885	34,921	16,777,828
1882	35,199	17,872,182	1886	38,261	18,068,065
1883	40,385	17,695,174			

Table showing the length of time navigation was open during each season, beginning with that of 1880.

Year.	From—	To—	Days.	Year.	From—	To—	Days.
1880	Apr. 3	Nov. 21	221	1884	Apr. 12	Dec. 16	247
1881	May 4	Dec. 17	226	1885	Apr. 14	Dec. 5	235
1882	Apr. 5	Dec. 7	215	1886	Apr. 3	Dec. 3	245
1883	Apr. 18	Nov. 18	213	1887	Mar. 23	.....	.....

For comparison the following statement is given of the number of loaded cars that passed Detroit River by the Great Western and Canada Southern Railways:

Year.	Loaded cars.			At an average of 12 tons to the car.
	East bound.	West bound.	Total.	
	Number.	*Number.*	*Number.*	*Tons.*
1883	150,058	107,209	257,267	3,087,204
1884	146,582	117,046	263,628	3,163,536
1885	178,825	115,693	294,518	3,534,216
1886	158,586	107,750	266,336	3,196,032

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K K 16.

PRELIMINARY EXAMINATION OF BAR IN ST. CLAIR RIVER, MICHIGAN, OPPOSITE SAINT CLAIR CITY.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter, dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: Bar in St. Clair River, Michigan, opposite Saint Clair City. * * *

The Lake Survey chart of St. Clair River shows this bar or shoal in sufficient detail to indicate the character of the improvement to be made, if any, and to furnish the information requisite for a general estimate.

It is situated nearly in mid-channel, opposite to and extending beyond the upper end of the city of Saint Clair. It is about 4,200 feet long between the 18-foot curves and about 600 feet wide, with a minimum depth of about 4 feet.

A much smaller shoal lying off the lower end of the larger one appears to have not less than 18 feet on it, and is therefore not considered.

The bar forms a middle ground, with a good channel on either side of it. The western channel, the one adjacent to the city of Saint Clair, is the deeper, and although narrower is still 600 feet wide. Nearly opposite Saint Clair are the Canadian towns of Moretown and Courtright, the latter being a station on the Saint Clair and Petrolia division of the Michigan Central Railroad, whence connection is made by ferry with the Michigan system of railways.

The middle ground is somewhat in the way of a ferry, and gives rise to some inconvenience in communicating between the two sides of the river.

The general commerce passing up and down the river is very great, possibly not less than 15,000,000 tons per annum. This shoal does not offer much obstruction to this, as the channel on either side is of sufficient width and depth for easy navigation by any vessel now on the lakes.

The obvious improvement is the removal of the shoal to the depth of 17 feet. The amount of dredging to do this is estimated at 160,000 cubic yards, and the cost at $40,000.

This would only be for present navigation; when the channels now in course of improvement shall have attained their full depth the benefit of the improvement to 17 feet will be lost unless the depth be then increased to 20 feet.

In view of the necessity existing elsewhere for improvements of greater importance, I find myself unable at this time to express the opinion that this bar is worthy of improvement by the General Government.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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K K 17.

PRELIMINARY EXAMINATION OF NORTH RIVER, MICHIGAN, BETWEEN ESSEX AND NORTH BRIDGES.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter, dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: * * * North River, Michigan, between Essex and North Bridges. * * * After diligent inquiry I have been unable to ascertain the location referred to.

A point of so little general importance as to be unknown to the persons consulted is, in my opinion, not worthy of improvement by the General Government.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Brt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

K K 18.

PRELIMINARY EXAMINATION OF BIDDLE'S POINT, AT MACKINAC HARBOR, MICHIGAN, WITH A VIEW TO A BREAKWATER.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter, dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: * * * Biddle's Point at Mackinac Harbor, Michigan, with a view to a breakwater. * * *

By the river and harbor act approved March 3, 1879, a survey and examination was directed for a breakwater at Mackinac, Mich.

The work was assigned to the late Major Harwood, who submitted his report (with map) under date of January 19, 1880 (printed at page 2055 *et seq.*, Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1880). This report and map furnish ample data for the preparation of a report upon the question of an examination and survey at Biddle Point, since one of the breakwaters proposed by Major Harwood was located at this very point. It seems quite unnecessary to repeat the description of Biddle Point given in the report referred to.

The conditions described remain unchanged, except that possibly the shore-line may have slightly receded, not, however, to such extent as to render it necessary to modify Major Harwood's estimates on that

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account. But the increase meanwhile in the cost of the principal material (timber) entering into the construction has been considerable, and it would not now be safe to estimate the cost of a breakwater located and built as he proposed at less than $125,000.

The commerce of Mackinac is probably less now than at the time Major Harwood's statistics were prepared. Hereto annexed is a statement of the entrances and clearances for the year 1884–'85, the latest available. Mackinac was discontinued as a sub-port on July 1, 1885.

The former report was not made under the requirement that the engineer should express an opinion as to whether the harbor is worthy of improvement by the General Government, a condition which now exists. However, the engineer gave a mild support to the proposition to form a snug harbor.

The occasions when a landing at Mackinac is rendered impracticable by heavy seas, or the harbor sought for refuge, are comparatively rare. This, taken in connection with the decadence of its commerce, due to the greater prominence of the neighboring towns of Cheboygan, Mackinac City, and Saint Ignace, compel me to express the opinion that the harbor is not worthy of improvement by the General Government.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

COMMERCIAL STATISTICS.

CUSTOM-HOUSE, GRAND HAVEN, MICH.,
Collector's Office, November 10, 1886.

SIR: Your letter, November 8, requesting to furnish you, through the deputy collector at Mackinac, all the particulars relative to the commerce at Mackinac, the collections, arrivals, and clearances, etc., during the latest complete year, received.

In reply I have the honor to state that Mackinac has been abolished as a custom-port July 1, 1885, and inclose you, therefore, a statement of the transaction from July 1, 1884, to June 30, 1885, besides the lines of steamers touching the above-named port.

I am, sir, very respectfully, your obedient servant,

C. N. A. BROWN,
Special Deputy Collector.

Gen. O. M. POE,
Corps of Engineers, U. S. A.

DISTRICT OF MICHIGAN, PORT OF GRAND HAVEN.

Transaction of the port of Mackinac during the fiscal year July 1, 1884, *to June* 30, 1885.

Vessels entered (37,610 tons)	73
Vessels cleared (37,850 tons)	75
Total (75,460 tons)	148
Collections	$52.69
Expenses	602.25

Lines of steamers touching the port of Mackinac.—Leopold and Austrian line; Hannah Lay & Company line; Northern Michigan line; Cheboygan, Mackinac and Sault Ste. Marie line; Grummond's line from Detroit; Detroit and Mackinac line (steamers City of Mackinac and City of Alpena); Green Bay and Mackinac line.

C. N. A. BROWN,
Special Deputy Collector.

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K K 19.

PRELIMINARY EXAMINATION OF HARBOR AT FORESTVILLE, LAKE HURON, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: * * * Harbor at Forestville, Lake Huron, Michigan. * * *

Forestville is situated on the shore of Lake Huron, about 47 miles north of the foot of the lake (head of St. Clair River), and about 14 miles south of the Harbor of Refuge at Sand Beach.

A small stream empties into the lake at Forestville, but it is not of sufficient capacity to be available for harbor purposes.

* * * * * * *

What the citizens want is a substantial dock, or wharf, built from the shore into the lake, to take the place of private docks destroyed by storms. But this is not such an improvement as would be of any value to the general commerce of the lakes. For this purpose a harbor at this point would necessarily be wholly artificial. The protecting works need not be so extensive as at Sand Beach, but the exposure is nearly as great, and they would have to be built equally strong.

The location best suited to the purpose is southeast from the village, where the 18-foot curve is at a distance of about 2,000 feet from the shore. To be of any value as a harbor a breakwater, say 2,000 feet long, should be built in 22 feet of water, at a distance of not less than 3,000 feet from the shore, with returns towards the shore provided with suitable entrances.

The aggregate length of the structures would be in the neighborhood of 5,000 feet, and the resulting harbor would have a capacity sufficient for all the shipping that would resort to it. The cost would approximate $600,000.

The whole commerce of Lake Huron passes this point, and there can be no doubt but a harbor, if built there, would often be a great convenience to shipping, but the short distance from the Harbor of Refuge at Sand Beach (only 14 miles) seems to reduce it to a mere convenience.

It surely is not a necessity, and in view of the great cost of constructing a harbor of any value to general commerce, I am constrained to report that, in my opinion, the harbor is not worthy of improvement by the General Government.

No survey is recommended, for the reason that the detail chart of the lake survey at this point is quite sufficient for the purpose of making a general plan, with estimates.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

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K K 20.

PRELIMINARY EXAMINATION OF PINEPOG RIVER, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz, * * * Pinepog River, Michigan. * * *

Pinepog (Pinnepog or Partridge) River is a small stream, less than 25 miles long, lying entirely within the limits of Huron County, Michigan. It empties into Saginaw Bay at the town of Port Crescent. By the river and harbor act approved June 10, 1872, an examination and survey was ordered at Port Crescent, the report upon which, dated February 24, 1873, is printed at pages 304 and 305, Report of the Chief of Engineers, for the fiscal year ending June 30, 1873.

That survey was amply sufficient for any purposes connected with the construction of a harbor outside the river, and I reported that "the construction of a harbor here would be at great cost, without any adequate benefit to the general commerce of the lakes." My opinion, as there expressed, remains unchanged in regard to the construction of an outer harbor. The act of August 5, 1886, only mentions Pinepog River, and the further discussion will be limited to it.

The appendix to the above report of February contains the following paragraph, viz:

> It having been suggested that the Pinnepog (or Partridge) River, at the mouth of which Port Crescent is situated, might be made available for the shelter of vessels, an examination of this water-course was made for a distance of about half a mile. The water is backed up by a dam situated near the mouth, raising it 2.25 feet above the level of the bay. The depth of water thus backed up is from 4 to 6 feet, with some rock at the bottom, but I cannot say whether bed-rock or bowlders. Its width varies from 100 to 200 feet. The mouth itself below the dam is almost completely choked up with sand, the accumulation of which is facilitated by the position of the dock diagonally across the mouth.
>
> Of course the dock, as well as the dam, would have to be removed if such an improvement of the river should ever be contemplated, the water in the river then having a depth of from 2 to 4 feet. The limited width of the river and the uncertainty about its bottom, joined to the objections heretofore stated as to the inaccessibility of the bay, render any recommendation of this scheme out of the question.

In order to ascertain the present condition of the river and the amount of commerce, present and prospective, that would be benefited by its improvement, I communicated with some of the best informed people of the village of Port Crescent. Several of them united in a letter from which I extract the following, viz:

> The present commerce is composed of lumber, salt, lath, shingles, hoops, staves, headings, cedar posts, coal, merchandise, machinery, and farm produce to a large extent. There has been a large amount of white sand shipped from this port this season to different ports on the lakes, principally to Lake Superior. There are two saw-mills, two salt-blocks, two general stores, one flouring mill, besides several stores and business shops of smaller note.
>
> The prospective commerce will be a marked increase in manufactories as well as in commodities if the river was rendered safe for vessels to enter, but on account of numerous wrecks of vessels off this port marine men deem it unsafe to enter or remain here, which is a great detriment to the business interests of the place.
>
> The present condition of the river is that a bar of sand has been formed at the mouth of the river and partly filled for some distance back. Of the dam, that at the mouth of the river, the upper part went out in the spring of 1885, but the founda-

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tions remain there still. Prior to the time this dam was put in, vessels had loaded for 80 rods up the river with 200,000 feet of lumber and went out all right, to our personal knowledge.

The nature of the obstructions are sand and foundation of dam at present, and with low water the river is 180 feet wide at narrowest place, and in some places 12 feet deep, others not over 4.

It might be rendered navigable for miles, but about 200 rods would be sufficient for the present.

It would be a public interest in the way of a place of safety for vessels on the bay in case of a storm, and by a safe entrance it would cause a large traffic with the outside, making a market for the products of this place, which is partly surrounded by a very fertile agricultural country, and no other improvement would give this place so bright a future as the proposed opening of Pinnepog River.

The town of Port Crescent has increased in population about 200 per cent. In business it has increased to a considerable extent.

Another prominent citizen writes as follows, viz:

Your letter of inquiry, dated November 8, duly received. Not being familiar with the matter to which you refer I had to confer with others, hence the delay. I believe the present obstruction at the mouth of the Pinnepog River is sand and an old dam. The river can be made navigable for moderate-sized vessels at no great outlay. The town has not increased to any extent in population or business, but I am satisfied that the present condition of the river is a great detriment to business.

It is to be presumed that these statements make the best arguments possible in favor of the proposed improvement. I do not believe any improvement of the river would render the harbor of much use as a harbor of refuge.

Vessels already in it would undoubtedly be well protected during storms, and this fact would give greater confidence to mariners and induce them to more readily resort to the place. The region tributary to Port Crescent is limited in area and in products. From the very nature of things there could never be any considerable commerce from the port, certainly not sufficient to warrant any large expenditure.

To make the harbor available would require piers on either side of the entrance extending to at least 14 feet of water, and the excavation of a channel of 100 feet in width for a distance of at least half a mile.

All this would cost more than seems to be warranted; hence, whilst sympathizing with the people in their desire to better their facilities, I am compelled to report that, in my opinion, Pinnepog River is not, at this time, worthy of improvement by the General Government.

A survey and examination at this point sufficient for the preparation of a plan and estimates for the improvement of the river would cost about $1,200.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Brt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

K K 21.

PRELIMINARY EXAMINATION OF ROUGE RIVER, MICHIGAN, AT ITS JUNCTION WITH DETROIT RIVER, AND UP THE RIVER TO BRIDGE OF SAINT LOUIS AND WABASH RAILROAD.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter, dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following

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localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: * * * Rouge River, Michigan, at its junction with Detroit River, and up the river to bridge of Saint Louis and Wabash Railroad. * * *

River Rouge is a comparatively short stream, emptying into Detroit River about 1 mile west of the present limits of the city of Detroit.

It is somewhat remarkable in depth of water in its lower reaches, having a channel of 11 feet at its mouth, and from 13 to 18 feet thence as far as examined, a distance of 1½ miles. Vessels have ascended it to Dearborn, a distance of nearly 10 miles by the course of the stream. From the channel of Detroit River to the bridge of the Saint Louis and Wabash Railroad the distance is nearly 4 miles. The present importance of Rouge River is a matter within my personal observation, and is very well shown in the accompanying statement of the business now transacted upon it. This bids fair to rapidly increase.

The principal value of the proposed improvement to the vessel interests in general will be the formation of a perfectly safe ice-harbor, where any amount of shipping can be laid up for the winter. In accordance with numerous precedents this, aside from any local interest, renders the river worthy of improvement by the General Government, and when taken in connection with the large and growing local business removes all possibility of doubt.

I therefore respectfully recommend that, taking advantage of this winter's ice to accomplish it, an examination and survey be made at as early a day as practicable, and estimate the cost at $1,200, as shown in detail in the appended estimate.

Respectfully submitted.

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen. U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF MR. GEORGE N. BRADY.

DETROIT, *November* 16, 1886.

DEAR SIR: In reply to your question as to the amount of business on the river Rouge, I have to say that I have made inquiry and find that the following manufacturing establishments are located near the mouth of that stream, and upon it.

(1) The glass works known as the Detroit City Glass Works, capital $100,000.
(2) The Delta Lumber Company, capital $100,000.
(3) The Anchor Manufacturing, capital $500,000.
(4) The Michigan Carbon Works, capital $400,000.

The latter company handles about 4,000 cars per American Railroad Cars, and wishes to increase its transportation facilities by water. The Anchor Manufacturing Company, during the season of navigation, loads and unloads about three vessels per week; has done this during the season of 1886, since they got fairly to work. They expect to handle one vessel per day in 1887. The Delta Lumber Company has received during the season of navigation 52 vessel-loads of lumber, or about 2 per week. It expects to increase its business about 25 per cent. next year. The Detroit City Glass Works have received about 20,000 tons of sand, wood, lumber, and coal by water, and have shipped glass in that way. If the facilities are increased they would probably average one or two vessels per week. Arrangements are about being made for other business, that leads me to believe that business at the Rouge will double within the next twelve months, and will steadily increase from year to year thereafter.

Very respectfully, your obedient servant,

GEORGE N. BRADY.

General O. M. POE.

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PETITION OF CHARLES W. NOBLE ET AL.

DETROIT, MICH., *November* 29, 1886.

DEAR SIR: The undersigned would respectfully represent that they believe there are good and sufficient reasons why the General Government should undertake the improvement of the navigation of the river Rouge, and among the reasons which they adduce in support of their belief, are the following:

That, at present, the following business enterprises are situated upon its banks, and dependent wholly, or in part, for their transportation facilities during the season of navigation upon said stream.

The Detroit City Glass Works, employing 75 men and requiring 20,000 tons of freight annually; capital, $100,000.

Fisher Bros. Glue Factory, employing 15 men; capital, $5,000.

The Delta Lumber Company, employing 100 men, and handling 18,000,000 feet of lumber yearly, which is received by water from their mills upon Lake Michigan; capital, $100,000.

The Anchor Barrel Manufacturing Company, employing 200 men; capital, $500,000. Used both for boats and rafts.

The Michigan Carbon Works, employing 250 men; capital, $400,000; and use 40,000 tons of material yearly.

The above-enumerated establishments occupy but a very small proportion of the available banks of said river, and are all within 3 miles of its mouth. A large number of equally eligible sites still remain, and your petitioners verily believe they would be speedily occupied were access thereto by large vessels assured.

The Michigan Central Railroad Company already has connections at two points with establishments upon this stream, and are preparing for the accommodation of other concerns desiring to locate thereon.

The stream has been continually navigated since the settlement of Detroit, and in 1812 the General Government located its arsenal and ship-yard for the building of vessels thereon.

As a winter harbor for the mooring of steam and other vessels it is unrivaled, and has been used for this purpose by many of the smaller craft which navigate these waters. At this date several light-draught side-wheel steamers are placed in winter-quarters within the mouth of this stream. With the recent enlargement of the size of vessels navigating the great lakes, it is not possible, with the present depth of water in the mouth of this stream, for them to enter, which they desire to do.

Your petitioners further assert that, in their opinion, the business depending upon the navigation of this river will, within the next twelve months, be double its present volume, and continue to increase in a large ratio thereafter. That the only available dock frontage adjacent to the manufacturing centers of Detroit's western suburbs is along this said stream, and that, in the near future, with the increased railroad facilities now being furnished, large transfer docks for the handling of coal ore, lumber, and other commodities, will be erected thereon.

The recent enlargement of the city limits in this direction has given an impetus to the building of dwellings, thus calling for large supplies of coal and wood for the use of its inhabitants, making this river a necessity to their well being.

For these and other reasons your petitioners believe that a preliminary survey will show that the small expenditure necessary for the improvement of this river is warranted.

Respectfully submitted.

CHARLES W. NOBLE.
GEORGE N. BRADY.
ANCHOR MANUFACTURING COMPANY, C. G. Robinson, secretary.
DELTA LUMBER COMPANY, by E. L. Thompson, president.
NEWBERRY & MCMILLAN, by W. C. McMillan.
MICHIGAN CARBON WORKS, D. Jarves, president.
FISHER BROTHERS.
DETROIT CITY GLASS WORKS, by Louis Blitz, proprietor.
A. W. COPELAND, postmaster.
JOHN MCGREGOR.

Col. O. M. POE.

EXAMINATION AND SURVEY OF ROUGE RIVER, MICHIGAN.

Operations under the immediate charge of Assistant Engineer H. Kallman were commenced on the 6th of June. A base line was measured and the requisite triangulation stations erected, and water gauges

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with bench-marks established. Soundings were taken at intervals of 10 feet across the river, and 20 feet apart in the direction of the current. The soundings have been reduced to zero of gauge, and approximate estimates prepared for a uniform depth of 16 feet, 240 feet in width at the mouth of the river and for a distance of 800 feet above, and then decreasing to 100 feet in width to the bridge of the Saint Louis and Wabash Railroad.

The material to be excavated consists of mud, sand, and clay, amounting to the following quantities, viz:

	Cubic yards.
From the mouth of the river to station XII, 300 feet above the Delta Lumber Company's dock, distance 6,592 feet	75,105
From station XII to river road bridge, 4,493 feet	59,789
From river road bridge to Saint Louis and Wabash bridge, 3,805 feet	57,169
	192,063

The following is the estimated cost of removing the material necessary to make the channel indicated above:

Dredging 192,063 cubic yards, at 15 cents	$28,809.45
Add 10 per cent. for contingencies	2,880.94
Total	$31,690.39

Herewith is transmitted a map of the survey.

The velocity of the current in the Rouge is governed by the rise and fall of Detroit River, a rise of four-tenths of a foot causing the flow to practically cease. A down-stream current is, however, the prevailing condition.

The river has sufficient depth to be navigable to Dearborn, a distance of about 15 miles. Within the limits of the survey it is, at present, crossed by three bridges, namely, one wagon road draw-bridge, which is now so much out of repair as to be impassable, and two railroad bridges without draws. The railroad bridges will soon be abandoned for a single drawbridge, now under construction for the use of both roads.

For a number of years the Rouge River has been used as an ice-harbor by vessels able to cross the bar at the mouth, and when this obstruction shall have been removed, many more vessels will be enabled to find here a perfectly secure harbor from the destructive floating ice of Detroit River.

The water front of Detroit River, above the mouth of the Rouge to the easterly city limits, being now fully occupied, except in the vicinity of the junction of the two rivers, manufacturing establishments must seek locations about the junction and along the Rouge. A very decided movement is now being made in that direction. Large interests like those of the Detroit City Glass Works, the Delta Company's Lumber docks, the Anchor Manufacturing Company, the Michigan Carbon Works, etc., are already established, and transact a business extending throughout many states. Their supplies of raw material are largely received from other states and from Canada, and the use of water transportation would become general if the river were improved to admit it.

I therefore respectfully recommend that Rouge River be improved in accordance with the foregoing project, and that the entire amount of the estimate be made available by one appropriation.

[Received with Lieut. Col. O. M. Poe's annual report for fiscal year ending June 30, 1887.]

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K K 22.

PRELIMINARY EXAMINATION OF MOUTH OF BLACK RIVER, SAINT CLAIR COUNTY, MICHIGAN.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 9, 1886.

SIR: In accordance with instructions conveyed by letter dated Office of the Chief of Engineers, September 27, 1886, and in compliance with the provisions of the river and harbor act of August 5, 1886, I have the honor to submit herewith a report in regard to each of the following localities, and an expression of opinion in each case as to whether it is worthy of improvement by the General Government, viz: * * * Mouth of Black River, Saint Clair County, Michigan. * * *

The proposed examination and survey at this point has in view the further removal of the shoal in St. Clair River in the vicinity of the mouth of Black River, that is to say, abreast of the city of Port Huron.

Under appropriations made in 1872, '73, '74, '75 and 1878, aggregating $56,500, this shoal was removed to such extent as to give a depth of 15 feet over its whole area. The project for the improvement was made in 1871, when the navigable depth across St. Clair Flats was only 13 feet.

This depth has since been increased to 16 feet, and to maintain the relations between the navigable depth and that upon the shoal in question so much of the latter should be removed as may be necessary to give a uniform depth of 17 feet over its whole area.

By the action already taken and appropriations made Congress has determined that the river is worthy of improvement by the General Government, and for that reason it may seem presumptuous in me to express an opinion in regard thereto. Yet the law clearly requires such expression, and I therefore state that, in my opinion, the river at the locality indicated is worthy of improvement by the General Government.

No additional surveys are recommended at this time, because the data at hand appears to be sufficient for all purposes of preparing a plan for making the improvement with estimates of cost.

The amount of deposit since the completion of the former improvement (in 1879) is estimated at an average of 6 inches over the whole area of the shoal, about 80 acres, and the amount of material to be removed to obtain a uniform depth of 17 feet over the whole area is estimated at 315,000 cubic yards, at a cost of 22 cents per cubic yard, including contingencies, or a total of $69,300.

Respectfully submitted,

O. M. POE,
Lieut. Col. of Engineers,
Bvt. Brig. Gen., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

MOUTH OF BLACK RIVER, SAINT CLAIR COUNTY, MICHIGAN.

The improvement proposed at this point has in view the further removal of the shoal in St. Clair River, in the vicinity of the mouth of Black River, that is to say, abreast of the city of Port Huron.

Under appropriations made in 1872, '73, '74, '75, and 1876, aggregating $56,500, this shoal was removed to a depth of 15 feet and afterwards

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increased to 16 feet over its whole area, the depth prior to beginning the work having been only 13 feet.

To maintain the relations between the navigable depth of the channels in the river and harbors and the shoal in question the depth on the latter should now be uniformly increased to 17 feet.

By the action already taken and appropriations made Congress has determined that the river at this point is worthy of improvement by the General Government, and for that reason it may seem presumptuous in me to express an opinion in regard thereto. But the law clearly requires such expression, and I therefore state that, in my opinion, the river at the locality indicated is worthy of improvement by the General Government.

No detailed survey was made, because the data at hand are sufficient for all purposes of preparing a plan and estimates for the improvement. The plan proposed is to simply remove, by dredging, all the material above the uniform depth of 17 feet. The amount of material is estimated at 315,000 cubic yards, and the cost at 22 cents per cubic yard, or a total of $69,300.

In order to carry on the work to advantage at least half of this should be appropriated for the fiscal year ending June 30, 1889, or, say, $35,000.

The special reason which makes this improvement desirable is the fact that the shoal projects so far into the stream that vessels of the heavier draught now prevailing on the lakes are compelled to make an abrupt turn to pass around it, and with long and heavy tows this is quite difficult.

[Received with Lieut. Col. O. M. Poe's annual report for the fiscal year ending June 30, 1887.]

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APPENDIX L L.

IMPROVEMENT OF HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA—IMPROVEMENT OF SANDUSKY RIVER.

REPORT OF MAJOR L. COOPER OVERMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887 WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky City Harbor, Ohio.
5. Sandusky River, Ohio.
6. Huron Harbor, Ohio.
7. Vermillion Harbor, Ohio.
8. Black River Harbor, Ohio.
9. Rocky River, Ohio.
10. Cleveland Harbor, Ohio.
11. Fairport Harbor, Ohio.
12. Ashtabula Harbor, Ohio.
13. Conneaut Harbor, Ohio.

EXAMINATIONS AND SURVEYS.

14. Chagrin River, at its mouth, Ohio.
15. Sandusky Harbor, Ohio, with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, August 23, 1887.

GENERAL: I have the honor to transmit herewith the annual reports of the works of river and harbor improvement under my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

L L 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

The harbor of Monroe, Mich., is situated at the extreme westerly bend of Lake Erie, about 1½ miles west of the old mouth of the Raisin River, and about 3½ miles from the town of Monroe.

This improvement was commenced in the year 1835, at which time the Raisin River was considered an important stream, and Monroe was

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a place of some prominence. The plan of improvement consisted in straightening the river and making direct connection with Lake Erie by a canal, 4,000 feet long and 100 feet wide, through a sand peninsula. A description in detail of the operations heretofore carried on for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

OPERATIONS DURING THE FISCAL YEAR.

The act approved August 5, 1886, appropriated $2,000 "for repairs" for this harbor. As the amount of repairs needed was considerable and would cost much more than the amount available, the contract method was not deemed advisable, and authority was obtained to expend the amount by hired labor and purchase in open market.

Work was begun in September, 1886, and continued until December, when ice and snow prevented further operations. Work was resumed in June, 1887, and continued until appropriation was exhausted.

The following named materials were expended in the repairs:

Pine timber and plank, for repair of piers	feet..	6,500
Oak timber and plank, for repair of revetment and pile protection	do....	22,000
Piles, containing 920 linear feet, for pile protection to pier		40
Cords of stone, for filling pockets of piers and for riprap		20
Screw and washer bolts, for piling and revetment	pounds..	200
Spikes, for decking	do....	500
Drift-bolts, for pier and revetment, together with such old material as was found serviceable	pounds..	500

With the above material and necessary labor, a portion of the work needing repairs the most was repaired. The piers and revetment of canal, however, are still in very bad condition, and portions of the piers below ordinary low water are badly rotted and gone.

General and thorough repairs, according to previous estimates, will cost about $20,000, but such an expenditure is not deemed necessary at present, as the commerce seeking this harbor is insignificant. Repairs to the amount of $5,000 to $6,000 are, however, badly needed, and should be made at once. After this amount has been expended a small annual expenditure for repairs, say $1,000, will, in my opinion, keep the pier and revetment standing until commercial interests seeking this harbor as an outlet shall require more extensive repairs.

The whole amount appropriated for this harbor to date has been $215,515.27, all of which has been expended.

PRESENT CONDITION OF THE HARBOR.

An examination of the channel of this harbor was made in June, 1887, extending from the docks at Monroe to the 14-foot curve in the lake. The soundings showed but slight changes in depth of channel from lake to Monroe, but the bar in lake beyond end of south-pier had increased somewhat, having a least depth of $8\frac{8}{10}$ feet for a short distance.

The following depths were found in June, 1887:

Least depth of water—	Feet.
In channel entering the harbor	13.3
In United States Canal	11.4
In channel from United States Canal to City Canal	9
Through the City Canal	13
In channel from City Canal to docks	9
In channel in front of lower docks	9
In channel in front of upper docks	8

The harbor of Monroe is in the collection district of Detroit, Mich. There is a fixed white light of the fourth order on the outer end of the west pier. The nearest work of defense is Fort Wayne, 30 miles distant.

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During the fiscal year ending June 30, 1887, the amount of revenue collected was $22.65.

The imports, consisting of telegraph poles, cedar posts, fresh fish, etc., amounted in value to $2,985. There were no exports.

Fifty-nine vessels, with an aggregate tonnage of 3,778 tons, entered; and 45 vessels, with an aggregate tonnage of 3,450 tons, cleared, during the fiscal year. The deepest draught of vessels entering was 11 feet.

Money statement.

Amount appropriated by act approved August 5, 1886		$2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,628.06	
July 1, 1887, outstanding liabilities	371.94	
		2,000.00
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

STATEMENT OF STATISTICS AND INFORMATION RELATING TO MONROE HARBOR, MICHIGAN.

[Prepared in compliance with circular letters from the Office of the Chief of Engineers, U. S. Army dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887, $215,143.33.

Amount estimated as required to complete the improvement, $20,000.

Approximate annual cost of preserving and maintaining same, $1,000.

The available depth for navigation in 1828, when improvement began, was 6 feet.

The commerce at that time is unknown, but was of considerable more importance than the commerce of the port is now.

The available depth for navigation is now 9½ feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected was $22.65.

The imports, amounting in value to $2,985, consisted of telegraph poles, cedar posts, and fresh fish. There were no exports.

Fifty-nine vessels, with an aggregate tonnage of 3,778 tons, entered, and forty-five vessels, with an aggregate tonnage of 3,450 tons, cleared.

The deepest draught of vessels entering was 11 feet.

The deepest draught of vessels clearing was 6 feet 2 inches.

The improvement of this harbor has had a very desirable effect upon manufacturing interests and public interests in general.

By the completion of the proposed improvement the prospective advantages to commerce would be a benefit only to the extent of an increased channel entrance, but it would not be liable to attract additional commerce to the harbor; the community would be indirectly benefited by the expenditure and by a better harbor.

L L 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

The city of Toledo, Ohio, is situated at the mouth of the Maumee River. The Maumee River empties into Maumee Bay at a point by way of the channel, about 7 miles from the deep water of Lake Erie.

A history of the operations carried on in past years for the improvement of this harbor will be found in the Annual Reports of 1880, 1881, and 1883.

The present channel, which is 250 to 300 feet wide at the angles, with a depth of from 15 to 17 feet at ordinary low water, has been obtained by seventeen appropriations averaging $41,650, and an annual average

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expenditure of about $41,320. It is probable that appropriations will have to be made for some years to come to complete this channel, and a continued annual expenditure of about $20,000 made to maintain the depth at present required, or until the straight channel is available.

The project for the old channel was adopted in 1872 and amended in 1880, so as to gain increased depth, provides for widening to 250 feet at surface and 200 feet at bottom, and deepening to 16 feet at low water the natural channel through Maumee Bay.

Congress by two appropriations has sanctioned the project for a "straight channel" from mouth of Maumee River to deep water in Lake Erie, and by act of August 5, 1886, the location was to be "along such line" as the Secretary of War might approve.

OPERATIONS FOR THE FISCAL YEAR.

At the beginning of the fiscal year no work was in progress, there being no funds available.

The river and harbor bill approved August 5, 1886, appropriated $112,500 for work on straight channel along such line as the Secretary of War should approve, and made the unexpended balance of the $25,000 appropriated in 1884 for the "straight channel" available for work to improve the "old channel." The then unexpended balance was $9,346.91. A project was submitted for the expenditure of this sum, which was approved. Proposals were invited and contract executed with Carkin, Slickney & Cram, of East Saginaw, Mich., for the required dredging. Preparations were made and work was begun October 18, 1886, and was continued with numerous interruptions and delays until December 2, 1886, when a very sudden and unexpected freeze-up decided the contractors to suspend operations till spring of 1887. The contract provided that the work should be completed by December 30, 1886, and it was expected that the work would be completed by that time. The contractors applied for and obtained an extension of time for its completion. Operations were resumed April 20, 1887, and by May 11 the available funds were exhausted and contract closed. Total amount removed under the contract was 45,397 cubic yards.

At the end of the fiscal year 1887 the condition of the old channel was as follows:

First. From the Toledo City docks to the Manhattan Range, a good wide channel with a least depth of 18 feet.

Second. The Middle Range, 576 feet long, had a width of from 160 to 170 feet, and least depth of 14.6 feet in dredged channel.

Third. The Phenstock Range, 5,055 feet long, had a width of from 162 to 220 feet (the latter width at the turns) and least depth of 15 feet in channel.

Fourth. The Can Range, 11,580 feet long, with width of from 120 to 190 feet at turns and least depth of 13.7 feet in dredged channel.

Fifth. The Turtle Island Range, 9,790 feet long and a width of from 75 feet across bars to 180 feet and least depth of 14.5 feet in the dredged channel.

Sixth. The Outer Range, 7,800 feet long and a width of from 60 feet to 190 feet with least depth of 15½ feet.

Full depth of 16 feet at the elbows and increased width given varying from 140 to 300 feet.

All soundings referred to the zero of the gauge. Increased width and depth are needed and the want of same is complained of. Complaints have been made from vessel men and owners during the season for want of greater depth in channel.

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A comparison of the condition of channel with that of close of 1886 shows a decrease in depth and a slight loss in average width of channel, which would indicate that with the removal of the annual deposits it will be necessary to provide for the removal of over 200,000 cubic yards for some seasons yet in order to secure the full depth and full width proposed by the improvement of the old channel.

The total amount appropriated to close of fiscal year for old channel for this harbor, since 1866, has been $714,046.91, all of which has been expended. The estimated cost of the project for old channel, viz, a channel with a least depth of 16 feet at ordinary low water and 250 feet in width at surface, was $570,000. Of this amount $519,346.91, to close of fiscal year, had already been appropriated and expended.

The balance of $50,000 originally estimated and yet to be appropriated will not complete the project, mainly from the lengthened period consumed in doing the work for want of adequate appropriations.

The estimate made in 1872 (amended in 1880) contemplated large appropriations, and consequently limited contingencies, whereas the appropriations have been small, requiring thirteen years to obtain $519,000, and contingent expenses and the annual removal of the deposits of each winter and spring have been repeated for these thirteen years, so that they have absorbed at least $100,000 of the original estimate. It will, therefore, require at least $150,000 to complete the projected improvement of the natural channel through Maumee Bay, all of which could be expended in one season in dredging to deepen and widen the natural channel through Maumee Bay.

The amount of commerce to be benfited is very large, and continues to grow in importance. Previous reports have given valuable statistics on this subject, to which attention is invited.

TOLEDO HARBOR, OHIO—"STRAIGHT CHANNEL."

For a history of this project and the work done to close of fiscal year ending June 30, 1886, see Annual Reports of 1884, 1885, and 1886.

OPERATIONS DURING THE FISCAL YEAR—"STRAIGHT CHANNEL" IMPROVEMENT.

At the beginning of the fiscal year there was a balance of $9,632.61 of the appropriation of $25,000 of the act of July 5, 1884. No work was in progress, nor was there any contract in force.

The act approved August 5, 1886, contained the following with reference to Toledo Harbor, Ohio:

> Continuing improvement of the Maumee River by a straight channel along such line as may be approved by the Secretary of War, $112,500 and the balance of the $25,000 heretofore appropriated are hereby made available for clearing the old channel.

This necessitated additional examination of the locality in order to determine which line to recommend for the action of the Secretary of War. Authority was asked for and obtained to make such examination. Field work was commenced in November, 1886, but on account of ice and inclement weather could not be completed until February 12, 1887.

The necessary office work and preparation of charts were at once commenced, and under date of March 17, 1887, I made a special report of this examination with recommendation (copy herewith, which I respectfully request may be printed and appended to Annual Report).

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This report was referred to "the Board of Engineers, U. S. A," for examination and report.

Under date of April 12, 1887, the Board of Engineers submitted their report (copy herewith) and recommended a line for straight channel, which report was recommended for approval by the Chief of Engineers, U. S. Army, and approved by the Secretary of War, under date of April 27, 1887.

The approved line differs in location and direction from all the lines heretofore suggested. A copy of the report, with letter of instructions, was received May 6, 1887. Preparations were at once made for commencing the work in accordance with instructions and the report of the Board of Engineers.

A project for the expenditure of the available funds was submitted under date of May 7, 1887, which project was approved. Proposals were at once invited to be opened May 31, 1887. All the bids received were rejected, being considered too high for the character of work. A new letting was made June 16, 1887, but all the bids were again rejected, as the "lowest bid" was not in conformity with the requirements. A third letting was had July 7, 1887, at which acceptable bids were received, and two contracts were executed, one with George Kellogg, of Fulton, N. Y., for dredging 423,000 cubic yards, more or less, at 12 cents per cubic yard, scow measurement; and one with French & Rooney, of Toledo, Ohio, for 370,000 cubic yards, at 15 cents per cubic yard, scow measurement.

Meanwhile the assistant engineer and party with aid of small steamer were employed in obtaining all the information practicable regarding the approved line, which being different in location from others heretofore considered made such examination especially necessary.

There have been thus far two appropriations for the "straight channel," viz: that of July 5, 1884, of $25,000, of which $15,653.09 was expended in connection with the line selected by Colonel Wilson (the balance transferred to old channel), and the appropriation of August 5, 1886, amounting to $112,500; making a total of $128,153.09, of which sum $17,708.66 had been expended at the close of the fiscal year June 30, 1887.

The estimated cost for completing the straight channel is calculated on the basis of cost heretofore estimated for other lines, since the Board of Engineers in adopting the approved line made no new estimate and left the question of protection of the dredged channel to be determined by future observation and experience.

The approximate estimate on said basis is $1,875,000, requiring, therefore, further appropriations amounting to $1,762,500 to complete.

All the available funds July 1, 1887, will be pledged to contractors for dredging during the present fiscal year, leaving nothing available July 1, 1888, for further work.

An abstract of proposals is transmitted herewith for the "straight channel" work, and an abstract of proposals and abstract of contract for old channel work are also transmitted herewith.

Toledo is in the collection district of Miami. There is a fixed white light of the fourth order on Turtle Island, and three sets of range-lights for parts of the channel.

The amount of revenue collected during the fiscal year ending June 30, 1887, was $21,305.

The imports, consisting of general merchandise, tin-plate hardware, lumber, etc., amounted in value to $59,915.

The exports, consisting of wheat, coal, timber, corn, staves, etc., amounted in value to $778,033 for the fiscal year ending June 30, 1887.

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Seventeen hundred and fifty-one vessels, with an aggregate tonnage of 516,405 tons, entered, and seventeen hundred and seventy-six vessels, with an aggregate tonnage of 526,590 tons, cleared, during the fiscal year ending June 30, 1887.

Of the vessels entering, the largest cargo was 650,000 feet of lumber, and the deepest draught was 12½ feet.

Of the vessels clearing, the largest cargo was 80,000 bushels of wheat, and the deepest draught was 14½ feet.

Money statement.

TOLEDO HARBOR, OHIO, OLD CHANNEL.

Amount appropriated by act approved August 5, 1886	$9,346.91
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	9,346.91
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

TOLEDO HARBOR, OHIO, STRAIGHT CHANNEL.

July 1, 1883, amount available		$9,632.61
Act of August 5, 1886, made the then balance available for old channel.		
Amount appropriated by act approved August 5, 1886		112,500.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,341.27	
July 1, 1887, outstanding liabilities	980.08	
		3,321.35
July 1, 1887, amount available		109,178.65
Amount (estimated) required for completion of existing project		1,762,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging 68,000 cubic yards, more or less, from old channel through Maumee Bay, at Toledo Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Tuesday, September 28, 1886, under advertisement dated September 8, 1886.

No.	Names and addresses of bidders.	Price bid per cubic yard, scow measurement.	
		For 34,000 cubic yards.	For all the excavation.
		Cents.	*Cents.*
1	S. P. & J. A. Smith, Cleveland, Ohio	29½	29½
2	W. J. Starkweather, Cleveland, Ohio	31	31
3	Stang & Gillmore, Lorain, Ohio	30	30
4	Carkin, Stickney & Cram, East Saginaw, Mich	20	16¼*
5	George Talbot, Buffalo, N. Y	30	30
6	William St. John, Toledo, Ohio	22	22
7	James Rooney, Toledo, Ohio	19½	.....
8	E. H. French, Fulton, N. Y	19½	22

* Lowest bid for all the excavation required.

Recommend that award be made to Carkin, Stickney & Cram, of East Saginaw, Mich., at the rate of 16¼ cents per cubic yard, scow measurement, for all the excavation.

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Abstract of proposals for the excavation of 846,000 *cubic yards, more or less, of material from Maumee Bay, along line of proposed straight channel for Toleldo Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at* 11 *o'clock a. m. Tuesday, May* 31, 1887, *under advertisement dated May* 7, 1887.

No.	Names and addresses of bidders.	Price bid per cubic yard, scow measurement, for all the excavation.	For portions of the excavation.	
			Bid per cubic yard.	Price bid per cubic yard, scow measurement.
		Cents.		Cents.
1	Stang & Gillmore, Lorain, Ohio	.25	141,000	.23
2	J. M. Eley and L. J. Seek, Toledo, Ohio	.24½		
3	William St. John, Toledo, Ohio		141,000	.24
4	Charles F. Dunbar, Buffalo, N. Y	.27		
5	Dodge & Petree, Chicago, Ill		141,000	.33
6	Charles B. Crane, Chicago, Ill	.27		
7	L. P. & J. A. Smith, Cleveland, Ohio	.24	(*)	*.25
8	George Talbot, Buffalo, N. Y†	.20	282,000	†.21
9	W. E. Rooney, Toledo, Ohio‡			
10	Carkin, Stickney & Cram, East Saginaw, Mich	.23½		
11	Edwin H. French, Fulton, N. Y		141,000	.21½

* One or more portions.
† Lowest bid for the whole or for part of the dredging, but considered high.
‡ Bid withdrawn before letting, unopened.

Recommend that the work be relet.

Abstract of proposals for the excavation of 846,000 *cubic yards, more or less, of material from Maumee Bay along line of proposed straight channel for Toledo Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at* 11 *o'clock a. m. Thursday, June* 16, 1887, *under advertisement dated May* 7, 1887.

No.	Names and addresses of bidders.	Price bid per cubic yard, scow measurement, for all the excavation.	For portions of the excavation.	
			Cubic yards bid for	Price bid per cubic yard, scow measurement.
		Cents.		Cents.
1	George Kellogg, Fulton, N. Y		282,000	*18
2	Rittenhouse Moore, Mobile, Ala	†14½		
3	Stang & Gilmore, Lorain, Ohio		143,000	23
4	James Rooney, Toledo, Ohio		141,000	21½
5	J. M. Ely and L. J. Seek, Toledo, Ohio		141,000	26
6	William St. John, Toledo, Ohio		141,000	25
7	Edwin H. French, Toledo, Ohio		141,000	21½
8	Thomas M. Hubbell & Co., Saginaw, Mich	23		
9	L. P. & J. A. Smith, Cleveland, Ohio	21½		

* Lowest bid for a part of the work. Recommend that award be made at 18 cents per cubic yard for 282,000 cubic yards, more or less, and that balance of work to the extent of available funds be readvertised.
† Lowest bid for all the work. Bidder is not prepared to begin work when required. Expects to be allowed ninety days to get prepared for beginning work, then proposes to do the work with one dredge of the claw-shell pattern. This inability to comply with requirements of the specifications is therefore considered as practically nullifying his bid.

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Abstract of proposals for the excavation of 846,000 cubic yards, more or less, of material from Maumee Bay, along line of straight channel at Toledo Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Thursday, July 7, 1887, under advertisement of June 27, 1887.

No.	Name and address of bidders.	Price bid per cubic yard for all the excavation, scow measurement.	Portions of the excavation.		Remarks.
			Cubic yards bid for.	Price bid per cubic yard, scow measurement.	
		Cents.		*Cents.*	
1	French & Rooney, Toledo, Ohio....	*15	.....	.....	
2	George Kellogg, Fulton, N. Y.....	.....	423,000	†12	‡Lowest bid for one-half the work.
3	George Talbot, Buffalo, N. Y.....	*16	.....	.....	
4	Stang & Gilmore, Lorain, Ohio	.....	146,000	†21	‡The next but one to the lowest bid for a part of the work.
5	Dodge & Petree, Chicago, Ill	.....	141,000	24	
6	William & J. W. St. John, Toledo, Ohio.	.....	141,000	†16½	‡Next to lowest bid for a part of the work.
7	L. P. & J. A. Smith, Cleveland, Ohio	*19½	.....	.....	
8	R. Moore, Mobile, Ala	§13$\frac{7}{10}$	.....	.....	

*Parties stated in writing that they wanted all the dredging or none.
†This bid is the lowest for all the dredging, but is not the most advantageous as to cost.
‡The aggregate of these three bids for portions of the dredging is lower than the cost of the same amount of dredging at the rate bid by French & Rooney, viz, 15 cents per cubic yard.
§Bid received by mail six hours after time fixed for opening of bids.

Recommend that award be made for one-half the work to George Kellogg, at 12 cents per cubic yard; for one portion to William & J. W. St. John, at 16½ cents per cubic yard, and for one portion to Stang & Gilmore, at 21 cents per cubic yard; making the average 14.7 cents per cubic yard.

ABSTRACT OF CONTRACT FOR IMPROVING HARBOR AT TOLEDO, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Contract with Carkin, Stickney & Cram, of East Saginaw, Mich., dated October 15, 1886, for dredging 52,000 cubic yards, more or less, of material from Maumee Bay, at Toledo Harbor, Ohio.
Rate paid, 16½ cents per cubic yard, scow measurement.
Contract time for completion extended to June 30, 1887.
Contract completed and closed.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO TOLEDO HARBOR, OHIO.

[Prepared in compliance with circular letters dated August 10, 1886, and April 4, 1887, from the Office of the Chief of Engineers, U. S. A.]

Amount expended on the improvement to June 30, 1887—	
Natural channel improvement	$714,046.91
Straight channel improvement	17,708.66
Estimated amount required to complete the improvement—	
Natural channel	150,000.00
Straight channel	1,762,500.00
Approximate annual cost of preserving and maintaining—	
Natural channel	20,000.00
Straight channel	25,000.00

The available depth for navigation at this harbor in 1867, when work of improvement began, was 11 feet.
The commerce at that time is unknown, but was considerable.
The available depth for navigation is at present time 16 feet.
The commerce for the fiscal year ending June 30, 1887, was as follows;
Amount of revenue collected was $21,305.

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The imports, consisting of general merchandise, tin plate, hardware, lumber, etc., amounted in value to $59,915. The exports, consisting of wheat, coal, timber, corn, staves, etc., amounted in value to $778,033.

Seventeen hundred and fifty-one vessels with an aggregate tonnage of 516,405 tons entered, and 1,776 vessels with an aggregate tonnage of 526,590 tons cleared.

Of the vessels entering, the largest cargo was 650,000 feet of lumber, and the deepest draught was 12½ feet.

Of the vessels clearing, the largest cargo was 80,000 bushels of wheat, and the deepest draught was 14½ feet.

The work of improvement thus far executed has been the means of a large reduction in the rates of freight and insurance—fully 50 per cent.

The completion of the proposed improvement would result in increased advantages to commerce by affording entrance to newly-built vessels of larger capacity and deeper draught. The community would be greatly benefited by the decrease in rates of freight, etc., the increased commerce and the general advantages to shippers consequent upon the completion of the proposed improvement.

As a further reply to the inquiries as to the "effect of work thus far executed," and the advantages and benefits to be gained by "completion of the proposed improvement," the following is submitted as received in a communication from Mr. D. D. Smith, secretary of the produce exchange at Toledo, Ohio:

"The importance of this improvement to the harbors of the principal ports on all the lakes is emphasized by the statement that a group of cities on their borders are closely identified with each other in a commerce of great and growing importance, and which partakes of the character of both national and interstate.

"During the season of navigation most of the grain for export to England and the continent is moved from the West along the water routes, and as a result imparts to this commerce its national character.

"The great and growing traffic in coal, iron, iron and copper ore, lumber, and salt may be more fairly termed interstate commerce. This free water-highway by the lakes and Erie Canal transports wheat from Duluth and Lake Michigan ports, a distance of 1,500 to 1,700 miles, at an average of 6½ cents per bushel. It is the great regulating influence to cheapen transportation and thus enhance values.

"The group of cities above referred to are Detroit, Mich., and the ports on lakes Michigan and Superior. The vessels engaged in this commerce, both steam and sail, as they become unseaworthy are replaced with those of largely increased capacity and draught of water. The vessels built in recent years have a capacity of 2,500 to 3,000 tons. These vessels are engaged in transporting wheat, coal, ore, iron, and lumber. Toledo is the largest lake receiver of bituminous coal. To illustrate: One of these vessels takes on a cargo of coal for Duluth. She returns with wheat to Buffalo or ore to Toledo or Cleveland. A clear and permanent advantage can only be gained by the principle of uniformity in depth of harbors; a want of it is a great disadvantage. One recent instance is a sufficient proof. The schooner *Golden Age* arrived at Toledo this month with a cargo of 2,430 gross tons of iron ore, equal to 3,000 tons of 2,000 pounds each, and it was necessary to lighten the vessel at great expense before she could enter our port.

"The improvement of Western harbors and the increase in capacity of the carriers has decreased the cost of freight year by year. This year may be called an exception, as there are some unnatural conditions controlling rates, which I have not space to discuss, but every one-half cent saved in the cost of transporting our agricultural products is of great importance. Briefly stated, this is the proposition: The sea-board value of grain is controlled by its value for export. Again, the sea-board value fixes the price for the daily purchase in the interior. A fair crop of cereals produces 3,000,000,000 bushels. One-half cent per bushel on such a crop, saved by cheapening transportation, produces $15,000,000. The United States Agricultural Department states that 90 per cent. of these cereals are now produced in the West.

"Toledo is one of the group of cities where improved harbor or bay facilities are necessary, and where such improvement affects the cost of transportation. Her grain traffic has increased from a little more than 12,000,000 bushels in 1866 to more than 37,000,000 bushels in 1886. She is a large center for grain, coal, ore, lumber, and salt. She is the largest receiver of wheat of any lake port. The leading points in her strong position are her location at the head of Lake Erie and the water-route to the American and Canadian sea-board, and the aggregate of her railway mileage leading up to her location. A fleet of steamers and barges of large class are engaged in transporting coal from, to all the Western ports, including Duluth, and in transporting to her (Toledo) iron ore and lumber in return cargoes. Her grain fleet includes many of those large vessels which prolong their trips to Buffalo.

"Toledo and all these ports should be equipped with equal and adequate harbor entrances that will facilitate commerce and thus relieve it as much as possible of its expenses.

"The receipts of coal alone at Toledo in 1886 amounted to 2,340,859 tons."

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SPECIAL REPORT RESPECTING IMPROVEMENT OF STRAIGHT CHANNEL.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, March 17, 1887.

GENERAL: I have the honor to submit the following report of the result of an examination for the best line for the "straight channel" for improvement of Toledo Harbor, Ohio.

HISTORY OF "STRAIGHT-CHANNEL" IMPROVEMENT.

The attention of the General Government was first called to the necessity of a straight channel from Toledo to deep water in Lake Erie by Col. T. J. Cram, Corps of Engineers, in 1867, and in 1868 he submitted a plan and estimate for such an improvement.

This plan was referred to a Board of Engineers convened in 1869, but was not approved on account of the cost and some objectionable features, the Board recommending the improvement of the natural channel.

In December, 1872, a Board of Engineers was convened "to examine into the condition of the navigation of the harbor of Toledo, and report a plan for its improvement," * * * and "to present, with their plan for the improvement of the harbor, an estimate of its probable cost."

This Board submitted three different plans for the improvement of the harbor.

First. Straight channel along a line similar to the one suggested by Colonel Cram, without revetment in the bay.

Second. Straight channel along a line similar to the one suggested by Colonel Cram, with revetment on both sides of the portion in the bay.

Third. To continue to improve the existing natural channel through Maumee Bay.

The Board deemed the second plan the most complete solution of the problem, but on account of the great cost of this plan and the pressing need of early relief to the harbor, they considered that the third plan could be made to answer the needs of commerce at that time. The improvement of the natural channel was therefore continued.

The act of Congress approved March 3, 1881, provided for an examination or survey "at Toledo, Ohio, for a straight channel to Lake Erie," with "estimates of cost of improvement" proper to be made.

Under date of November 19, 1881, Maj. J. M. Wilson, Corps of Engineers, submitted his report of a survey made in accordance with terms of act of 1881. Major Wilson in his report adopted the revetted channel or canal, as mentioned in the report of the Board of Engineers in 1872, which plan provided for extending Maumee River on a straight line through the bay and across North Cape Point to deep water in Lake Erie, confining the outflow from the Maumee River in a new channel of about the same dimensions as its natural bed.

His estimate for this plan was $2,363,923.

The route for this revetted straight channel was one located by Major Wilson, and to the west of the line approved by the Board of Engineers in 1872.

No positive action was taken upon Major Wilson's report at the time.

The act approved July 5, 1884, contained the following with reference to improving harbor at Toledo, Ohio:

> And the Secretary of War is hereby directed to commence the work of making a straight channel for the Maumee River from a point on the east side of the mouth of said river, through North Cape Point to Lake Erie, in accordance with the second plan recommended by John M. Wilson, major of engineers, on the 19th day of November, 1881, and for that purpose the sum of $25,000 is hereby appropriated,

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In response to letter from the Chief of Engineers, U. S. Army, calling for a project for the expenditure of the $25,000 appropriated by act of 1884, I recommended, as the amount was so small, that it be retained until further appropriations made the sum sufficiently large to properly begin the work of the magnitude of the one in question.

This recommendation was approved by the Chief of Engineers, U. S. Army, and no operations were undertaken during the fiscal year ending June 30, 1885, in connection with "straight-channel" improvement.

Under date of April 23, 1885, in forwarding a communication from citizens of Toledo, Ohio, urging the expenditure of the $25,000, I suggested that before making any expenditure of funds and definitely fixing the line for the "straight channel," that further examination be made to determine whether the line designated by act of July 5, 1884, "is the best line" or not.

At the beginning of the fiscal year ending June 30, 1886, a vigorous effort was made by the citizens of Toledo to have the straight-channel work begun by the expenditure of the $25,000 in dredging.

Their efforts were successful, and the expenditure was ordered to be made. Under date of August 15, 1885, I was instructed by the Chief of Engineers to take the necessary steps to begin dredging along a section of the line located by Major Wilson.

A contract was made and 130,000 cubic yards removed by the end of November, 1885. The amount of funds available for the work and the limitation imposed as to the section for work did not give any opportunity of solving by direct experiment the question discussed by many as to whether "an unprotected channel on a straight line from the mouth of the river through Maumee Bay would fill up, or remain the same, or gain increased depth during winter and spring storms."

The soundings in this cut taken this season indicate but little, if any, fill in the cut made in the fall of 1885.

Meantime considerable difference of opinion existed as to the best line for the proposed straight-channel improvement.

Some favored the line selected by Major Wilson, while others favored the line selected by Colonel Cram and others a line between the two.

As there were strong reasons advanced in support of the various lines and as the improvement proposed was both important and expensive, I suggested in letter to the Chief of Engineers, U. S. Army, dated April 22, 1886, that the item for Toledo Harbor in the river and harbor bill then under discussion by Congress be so amended as to allow the best line to be selected, and the restriction imposed by the wording of the act of July 5, 1884, removed.

The act approved August 5, 1886, contained the following with reference to improving harbor at Toledo, Ohio:

Continuing improvement of Maumee River by a straight channel along such line as may be approved by the Secretary of War, $112,500; and the balance of the $25,000 heretofore appropriated is hereby made available for clearing the old channel.

In response to letter from the Chief of Engineers, U. S. Army, calling for a project for the expenditure of the money appropriated by act of August 5, 1886, I recommended as follows:

(2) *The "straight channel."*—The clause of the act approved August 5, 1886, by its terms ignores the appropriation of 1884.

The act of 1884 designated a particular line and particular plan. The act of 1886 leaves the selection of a line for a "straight channel" to the Secretary of War. It in effect makes the present appropriation of $112,500 the original appropriation for the improvement. It would seem that Congress, in making the proviso, took into consideration the fact that considerable doubt exists as to whether the line designated by act of July 5, 1884, is the best line for the proposed straight channel. In order

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that a proper and reliable recommendation be made to the Secretary of War for his action, it would seem to me necessary that further examination should be made of the locality through which the straight channel must go in its course through Maumee Bay to determine the best line. I have therefore to respectfully recommend that before making project for the expenditure of the $112,500 appropriated by act of August 5, 1886, that I be directed to make further examination along proposed lines in order to make proper recommendation in the case.

This was approved and an examination ordered under date of October 14, 1886.

THE EXAMINATION.

Preparations were at once made for making the examination, and Mr. W. T. Blunt, the principal inspector, then at Toledo Harbor, Ohio, superintending dredging operations to clear the "old channel," was instructed to locate the various lines advocated, take soundings along same, to make the necessary borings to determine the character of the bottom, and obtain all necessary data to determine the selection; the examination to be made at such times when himself and party were not engaged with dredging operations. But few opportunities occurred during October and November for making the examination.

A sudden freeze-up of the bay early in December, however, caused a suspension of dredging operations, and from that time until February 12, 1887, the examination was continued in bay and lake whenever weather and ice permitted of same.

Much difficulty and many interruptions were met with, as the ice was continually shifting and breaking up, so that operations from the ice surface were very difficult and there was too much ice to make the examination from boats.

The line located by Major Wilson was taken as the westerly limit of the locality for examination, and the line of Colonel Cram was assumed as the easterly limit.

A very large number of soundings were taken both inside and outside of North Cape Point along the various lines, and a large number of borings into the bottom were made to determine the character of same as foundation upon which cribs and other structures must be located.

The present position of the lines of 16 feet depth and 17 feet depth were also located in order to determine the distance along the various lines, outside of North Cape Point, to reach deep water in the lake.

A careful examination of the "cut" dredged in the fall of 1885 was also made to determine the amount of fill during the winter and spring.

DISCUSSION OF THE VARIOUS LINES.

The objections made to the line located by Major Wilson are its proximity at the lake end to the adjacent shore, thereby giving a bad "offing" for vessels seeking entrance to the channel; its bearing when prolonged, not carrying it into deep water of the lake, but following the shore; its extra length outside of North Cape Point to deep water, and its proximity inside to the outflow from Ottawa River.

The objections made to line located by Colonel Cram are the character of the bottom through which line with his location must pass, being too soft and yielding for cribs to rest securely upon; the proximity at its lake end to the shoal water eastward, and the need for protection on both sides of the cut inside of North Cape Point.

The examination this season confirms the above objections.

The borings indicate that the bottom is soft and unreliable in the vicinity of the Cram line, and that it grows harder as we approach the

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Wilson line, and the farther east we go from the Wilson line the better the offing, up to a certain distance, when nothing is gained in offing by going east.

All this leads to the selection of a compromise line, which it is thought has the advantages of both lines, and the objectionable features in a modified form.

It is a line with the best offing compatible with good bottom.

THE LINE RECOMMENDED.

The line selected is indicated on the accompanying tracing and lake-survey chart. From an inspection of the tracing and lake-survey chart it will be seen that the offing for the selected line is good, both as regards the adjacent shore and the shoal near Turtle Island, and that the line prolonged extends into deeper water of the lake.

The bottom along the line is good, and a cut along the selected line will need no more protection inside than the line selected by Major Wilson, and being shorter outside of North Cape Point, the expensive protection by cribs or otherwise is diminished and a large saving of cost made.

It is protected in part by the marsh land on its west bank (inside of North Cape Point) from the outflow from Ottawa River, and a new outlet into the lake for said stream can be made to the west of the selected line. The amount of excavation to make 17 feet is less than along the Wilson line, and about the same as along the Cram line. Its adoption will necessitate the loss of the dredged cut made along the Wilson line in the fall of 1885; but this loss will be more than balanced by decrease in cost of dredging and outside protection consequent upon a shorter line.

I have therefore to respectfully recommend for the action of the Secretary of War, as per terms of the act of August 5, 1886, a straight channel, beginning at the intersection of the inner and middle ranges of the existing channel (marked by a red can buoy), running north 26° 36′ 13″ east, through North Cape Point to depth of 17 feet in the lake, and terminating about 10,258 feet north 1° 1′ 20″ west of Turtle Island Light, designated on accompanying tracing and chart as line recommended by Maj. L. C. Overman. Further, whatever line for the "straight channel" may be selected, I would respectfully recommend that the appropriation of August 5, 1886, be expended in dredging. The channel or cut to begin inside of and to pass through North Cape Point to deep water in the lake, and to be excavated to such width and depth as the funds will pay for, less a sum sufficient to protect the cut through North Cape Point, and to protect the entrance of same into the lake approximately.

For dredging	$90,000
For protection of the ends	20,000
Total	110,000

No expenditure for revetment of the cut inside or protection of the cut through North Cape Point and outside same is recommended for the present, but with further appropriation and with increased knowledge of the requirements, gained from actual observation, the proper and necessary revetment can be undertaken.

If experience shows, and only experience can show, that the cost of maintaining an unrevetted channel will not be excessive in comparison with the maintenance of a revetted channel, and that the annual expense be less than the interest on the cost of making a revetted chan-

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nel, then dredging will be the best method and the one that will give the speediest relief to navigation by the earliest completion of the new channel.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, April 12, 1887.

GENERAL: The Board of Engineers, to which was referred by Department indorsement of March 24, 1887, the report of Maj. L. C. Overman of an examination and project for a straight channel for improving Toledo Harbor, Ohio, with directions to report and recommend "the best plan and location to be adopted for the straight channel in question," has the honor to report:

That, including the location suggested by Major Overman, four positions for a straight channel from the mouth of Maumee River through Maumee Bay and to the deep waters of Lake Erie have been proposed.

The first location was that of a ship canal carrying 13 feet of water, suggested by Bvt. Maj. Gen. T. J. Cram, colonel of engineers, in his report dated December 27, 1868, which canal, commencing at a point in the channel about 1 mile outside of Presque Isle Point in 13 feet of water, was extended in a right line just to the eastward of North Cape Point, and terminated in the lake in 13 feet of water.

The length of the canal was 7,350 yards, or 4.1 statute miles.

In the bay the canal was to be 200 feet wide at bottom and 260 feet at the water-surface.

Across the ground of the cape it was to be 300 feet wide at bottom and 352 feet at the water-surface, and in the lake it was to be 250 feet wide at bottom and at water-surface.

The portion of the canal in the bay was to be revetted on the eastern side with a wood and earth revetment, and on the west side partially with an earth embankment.

Across the point there was to be no revetment, while at first the portion in the lake as far out as 10 feet water was to be inclosed between parallel piers filled with stone and earth.

The estimate made by General Cram of the cost of the work was $885,526.

The second location was that of a board of engineer officers, convened December 21, 1872, to report a plan for an entrance channel to the harbor of not less than 15 feet depth at the lowest stage of water, and was practically the line selected by General Cram.

It commenced at the same point outside Presque Isle Point as the Cram line, and was drawn tangent to North Cape Point at its eastern extremity, thus placing the line but a short distance to the westward of the Cram line.

The length of the straight channel was 7.3 miles. Two methods of construction were proposed:

The first, to dredge the entire line to a bottom width of 250 feet; to protect both sides of the cut in the lake out as far as 14 feet of water by strong crib-piers, and to divert the waters of the Ottawa River by a

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dam across its mouth with a cut into the lake. The estimated cost of this method of construction was $1,853,500.

The second method of construction was to extend the river banks through the bay and North Cape Point to Lake Erie, ignoring the bay altogether and confining the river water in a new channel of about the same dimensions as the natural one.

This would require the piers to be 900 feet apart to avoid ice gorges in the winter.

The channel to be dredged to a width of 250 feet only.

In the bay the east side of the channel was to be protected by crib or pile-piers; but on the west side of this channel a plank revetment of the simplest and cheapest construction was considered sufficient.

The Ottawa River was to be deflected as in the first method of construction. The cost of this construction was estimated at $3,074,500.

The third location was that of Maj. J. M. Wilson, brevet colonel U. S. Army, detailed in his report of November 19, 1881, and having in view a straight channel carrying 17 feet of water.

The line commenced at the same point near the mouth of the Maumee River as those already mentioned and, following the general direction of the river proper at that point, was carried through the sand beach of North Cape Point at its narrowest part.

The cut was to be 250 feet wide at bottom and about 5.9 miles in length.

Two methods of construction were proposed:

The first to simply dredge the channel to the width and depth proposed, without any additional works in the shape of revetments or piers or deflection of the waters of the Ottawa; the cost of this construction was estimated at $823.813.

The second method of construction provided for extending Maumee River on a straight line through the bay and North Cape Point to Lake Erie, confining the river-bed in a new channel of about the same dimensions as its natural bed.

From the east side of the mouth of the river to North Cape Point a strong pile and timber dike was to be run on the east side of the new channel as far as the inner end of the canal through North Cape Point, the height of the dike being such that the ice could pass out over the inner portion of it during freshets.

No dike was to be used on the west side of the channel until Nagg's Island was reached; but from the southeast end of this island a timber dike was to be run to the west side of the inner end of the canal through the peninsula.

The revetments of the canal across the peninsula were to be 400 feet apart, and this width was to be maintained between the piers out to the depth of 17 feet in the lake. The estimated cost of this construction was $2,363,923.

The fourth location is that proposed by Maj. L. C. Overman, and contained in his report of March 17, 1887, now referred to the Board of Engineers. The cut begins near the mouth of the Maumee River, at the same point as the other lines mentioned, and is carried in a straight line north 26° 36′ 13″ east, through North Cape Point to 17 feet depth of water in Lake Erie, which places it in a position about midway between the Cram and Wilson lines.

It is proposed to turn the waters of Ottawa River into Lake Erie by means of a cut through North Cape Peninsula, and a training-dike from the right bank of the Ottawa at its mouth.

For the present it is not proposed to revet the sides of the cut, which it is recommended should begin inside of and pass through North Cape

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Point to deep water in the lake, and to be excavated to such width and depth as the funds available will pay for.

The Board has carefully considered the location of these four lines and the advantages and disadvantages which they each possess, and is unable to recommend the construction of either of them. The present channel leading from the mouth of Maumee River to Lake Erie has been largely excavated over the site of the natural channel, or the one which resulted from the combined action of the waters of the lake, the bay, and the rivers emptying into the bay, as affected by the winds, waves, currents, and freshets of these bodies of water.

This channel is the one most likely to remain open and to maintain the depths artificially given to it, and any straight cut to the deep waters of the lake should, other things being equal, utilize as far as possible the direction and position of the natural channel. 1. The Board has, therefore, to recommend that the straight channel from the Maumee River to Lake Erie, directed by the acts of Congress of July 5, 1884, and August 5, 1886, be obtained by extending the Crib Reach, so called, of the present natural channel outwards into Lake Erie and inwards across the bay to the present natural channel of the Maumee River. By this means a stretch of the present channel over 2 miles in length will be preserved and utilized, while the portion of the line extending into the lake will pass over and along the "east channel," now deepening its waters. The lake end of this cut is better located with reference to the adjacent shores than either of the other lines for the arrival and departure of vessels, and does not materially increase the distance to be passed over by the Detroit trade. The quantities to be excavated and cost of same upon the several lines suggested to give a channel 17 feet in depth and 200 feet wide at bottom, with side slopes of 1 upon 2, prepared by Major Overman, are as follows:

APPROXIMATE ESTIMATE.—*Tabulated statement for several suggested lines to give a channel through Maumee Bay 17 feet in depth, 200 feet wide at bottom, with side slopes of 1 to 2.*

[Length of line inside of general shore-line of Lake Erie and outside to 17-foot curve in lake.]

	Inside.			Outside.			Total.		
	Length.	Amount of excavation (place measurement) for 17 feet.	Cost, at 14 cents per cubic yard, place measure.	Length.	Amount of excavation (place measurement) for 17 feet.	Cost, at 20 cents per cubic yard, place measure.	Length.	Amount of excavation (place measurement) for 17 feet.	Cost, place measure.
Line for a straight channel from mouth of Maumee River to 17-foot depth in Lake Erie, as suggested by:									
(1) Colonel Cram, in 1868, N. 47° 34′ 18″ E	*Feet.* 13,930	*Cubic yds.* 1,128,300	$157,962	*Feet.* 20,000	*Cubic yds.* 794,000	$158,800	*Feet.* 33,930	*Cubic yds.* 1,922,400	$316,762
(2) A Board of Engineers, in 1872, N. 45° 57′ 34″ E	13,860	1,522,400	213,136	19,900	467,300	93,460	33,760	1,989,700	306,596
(3) Colonel Wilson, in 1881, N. 26° 36′ 13″ E.	16,740	1,698,700	237,818	16,950	864,700	172,940	33,690	2,563,400	410,758
(4) Major Overman, in 1887, N. 35° 34′ 16″ E.	15,400	1,408,000	197,120	15,150	528,600	105,720	30,550	1,936,600	302,840
(5) The Board of Engineers, in 1887, N. 57° 39′ 51″ E	24,300	950,000	133,000	16,050	630,000	126,000	40,350	1,580,000	259,000

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Observations upon the dredged channels in Maumee Bay within North Cape Point would seem to show that the annual deposits in the channel are small.

General Cram states that near the mouth of the Maumee River and for some distance out the filling in twelve years was but 18 inches, while beyond North Cape Point the changes were not so great. Major Wilson was of opinion that the dredged channel within the bay could be maintained without much trouble by annual excavations.

Major Overman reports the portion of the straight cut on the Wilson line, made in 1885, did not show in 1886 any perceptible shoaling.

Outside of a line joining North Cape Point and Cedar Point it is highly probable that some protection will have to be given the dredged channel on one or both of its edges.

The material of the lake bottom is washed back and forth along the shores of the lake in directions coinciding generally with the direction of the winds and waves.

The easterly and westerly gales across the mouth of Maumee Bay will therefore have a tendency to fill the dredged channel proposed by the Board outside of the crib pier; but it is also thought that in the summer season, when the westerly winds prevail, considerable protection will be obtained against the cross-drift from the west by Turtle Island and the shoals about it, while in the winter season, when the easterly gales prevail and the lake is covered with ice, there will be less sea and less wash from the east across the channel than would occur in the ordinary storms of summer.

However this may be, experience only can determine the nature and extent of the possible deposit in the dredged straight cut and the character and position of the revetment necessary to protect the channel from the cross-drift of material.

It is not unlikely that less extensive barriers than the solid crib-piers heretofore suggested may be sufficient to revet the channel, and that stone and brush piers of moderate height may answer the purpose, even if located some distance on either side of the dredged cut; and it may even be the case that the annual cost of maintaining the necessary depth in the straight cut by dredging will be less than the interest upon the money that would have to be spent in revetments. The Board recommends that the straight channel located by it be first excavated throughout its whole extent to a width of 200 feet on the bottom and a depth of 17 feet below average low water; that the portion of this cut from the inner end of the crib-reach to the mouth of Maumee River be first excavated, and lastly, the part of the cut from the outer end of this crib-reach to the deep water of the lake.

That in making the cut no attempt to excavate slopes to the sides of the channel shall be made, but the cut shall be 200 feet wide square down, and as the sides fall in they shall be again dredged.

That after the entire cut is made, and it should be found necessary, a short pile and brush dike be run out from Grassy Point, or its vicinity, to throw the current of the river into the cut.

That careful and continuous observations be made by the local engineers during the progress of the excavation to determine the directions of the currents with reference to the cut and the amount of deposit and fill in given periods of time.

A map showing the positions of the several cuts proposed, with a

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longitudinal section of the cut proposed by the Board, is transmitted with this report.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
WM. P. CRAIGHILL,
Colonel Corps of Engineers.
D. C. HOUSTON,
Lieut. Col. of Engineers, Bvt. Colonel.
WALTER MCFARLAND,
Lieut. Col. of Engineers.
W. R. KING,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
April 25, 1887.

Respectfully submitted to the Secretary of War.

The river and harbor act of August 5, 1886, in making appropriation for a straight channel for Maumee River, removes the restriction imposed by the river and harbor act of July 5, 1884, as regards its location, and directs that the channel shall be "along such line as may be approved by the Secretary of War."

In the within report the Board of Engineers unanimously recommends, for reasons given, a line differing in direction from all those heretofore suggested.

The conclusions of the Board are concurred in by this office and recommended for approval.

This being a new work, it is further recommended that Major Overman, the officer in charge, be authorized to proceed with the work in the manner and upon the location recommended by the Board.

J. C. DUANE,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT,
April 27, 1887.

Approved as recommended by the Chief of Engineers.

By order of the Acting Secretary of War.

JOHN TWEEDALE,
Chief Clerk.

L L 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

Port Clinton, Ohio, is situated at the mouth of the Portage River, a stream which rises in the northwestern part of Ohio and empties into Lake Erie.

A history of the operations heretofore carried on for its improvement will be found in annual reports of 1880 and 1881.

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The present project, adopted in 1875, consists of a pile revetment, 967 feet long, running from the north shore of Portage River opposite the town out into the lake, in a direction north 57 degrees east. This revetment then inclines toward the north and extends 301 feet further, when a pile-dike commences, which will be prolonged a total distance of 1,200 feet out to a depth of 10 feet at the ordinary level of the lake.

Parallel to this and 200 feet from it is an east pile-pier which will be about 2,600 feet long, its inner end resting on the south shore of the river. This east pier will be a simple pile structure of 2,450 feet; the outer 150 feet will be a strong pile-dike, 12 feet wide. A channel 10 feet deep will be dredged between the piers.

OPERATIONS DURING THE FISCAL YEAR.

The river and harbor bill approved August 5, 1886, appropriated "for improving harbor at Port Clinton, Ohio, by repairs to existing works," $2,000.

Proposals were received May 23, 1887, and a contract for making the necessary repairs to the extent of the available funds was executed with John Stang, of Lorain, Ohio, under date of June 23, 1887.

Material was delivered during June, and actual operations will be commenced early in July. The available funds will all be expended by August 30, 1887. The whole amount appropriated for this harbor to date has been $48,000, of which sum $46,018.50 has been expended to close of this fiscal year.

The estimated cost of the present project, as submitted in 1875, was $122,000, a revised estimate being $90,000. The project contemplated the extension of the pier and revetment to the 10-foot depth in lake at ordinary stage of water.

The river and harbor bill approved August 5, 1886, contained the following with reference to this harbor:

> For the purpose of acquiring the title to the land adjoining the inner end of the west pier built by the United States for the improvement of the harbor at Port Clinton Ohio, the Secretary of War shall negotiate with the owner or owners of the land for the purchase thereof at a reasonable price, to be approved by Congress, and if an agreement as to price can not be made with the owner then the value of same shall be ascertained in the mode provided by the laws of Ohio for condemnation of lands for public uses in that State, the result of said proceedings of condemnation, if taken, to be reported to the next Congress for its approval.

Some correspondence has passed between the owner of the land in question and the engineer officer in charge of the harbor, but up to the end of the fiscal year no agreement as to price had been arrived at. The owner holds the land at a high valuation, as he obtains a good revenue from same by the sale of the sand from off it, which sand accumulates each year by the action of the lake waves. The owner is also adversely disposed towards condemnation proceedings.

The sum of $46,000 has been appropriated and expended up to the close of the fiscal year ending June 30, 1886, but as the commerce of Port Clinton is small, and prospects for much increase in the near future are not great, it is doubtful whether the expenditure of the remaining $44,000 for the completion of the proposed project, under the revised estimate, would be advisable.

If it is decided to continue the improvement as proposed, the sum of $20,000 can be expended during the period ending June 30, 1889, in prolonging the pier and revetment.

An examination of the channel of this harbor was made in June, 1887. The depth between the pier and revetment, wherever the same

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were parallel, was found to be good, averaging from 10 feet to 15 feet; but at the elbows, where divergence occurs, the depth was only 8 feet. A bar has formed in lake beyond end of piers, with least depth of 7.9 feet on crest of bar.

An abstract of proposals and an abstract of contract are transmitted herewith.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest work of defense is Fort Wayne, Mich., 60 miles distant, and the nearest light-house is at Green Island, 10 miles distant. The amount of commerce to be benefited by this improvement is small. For miles above the mouth of Portage River and bordering upon its banks are extensive tracts of hard-wood timber, from which lumber, staves, spokes, etc., are made and sent to Port Clinton for shipment.

The collector, in his report for the fiscal year ending June 30, 1887, does not state the amount of revenue collected nor the nature and value of the imports and exports.

Fifty-four vessels, with an aggregate tonnage of 2,896 tons, entered this harbor from other districts, and 48 vessels, with an aggregate tonnage of 2,560 tons, cleared this harbor for ports in other districts during the fiscal year ending June 30, 1887. Of the vessels entering, the largest cargo was 400,000 feet of lumber and the deepest draught was 10 feet. Of the vessels clearing, the largest cargo was 12,000 bushels of wheat and deepest draught was 9½ feet.

The collector, in his report, says:

This does not include business that is done exclusively in the district, which amounts to over three times the amount reported as above.

Money statement.

Amount appropriated by act approved August 5, 1886		$2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$18.50	
July 1, 1887, outstanding liabilities	20.84	
		39.34
July 1, 1887, amount available		1,960.66
Amount (estimated) required for completion of existing project		42,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing the materials and doing the work of repairs to pier and revetment at Port Clinton Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Monday, May 23, 1887, under advertisement dated April 20, 1887.

Material.		John Stang, Lorain, Ohio.*
White oak, 15,949 feet, B. M.	per M feet, B. M.	$39.00
Piles, 2,160 linear feet	per linear feet	.35
Filling stone, 45 cords	per cord	5.50
Riprap stone, 20 cords	do	5.50
Brush, 22 cords	do	3.50
Drift-bolts, 82 pounds	per pound	.03
Spikes, 785 pounds	do	.04
S. and W. bolts, 1,503 pounds	do	.04
Total		1,905.79

*Only bid considered reasonable and advantageous for the Government to accept.

Recommend that award be made to John Stang, of Lorain, Ohio, at the prices named in his proposal.

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Abstract of contract for improving harbor at Port Clinton, Ohio, in force during the fiscal year ending June 30, 1887.

[Contract with John Stang, of Lorain, Ohio, dated June 23, 1887, for repairs to pier and revetment at Port Clinton Harbor, Ohio.]

Material.	Amount.	Material.	Amount.
White oak.....per M feet, B. M..	$39.00	Brush.....per cord..	$3.50
Piles.....per linear foot..	.35	Drift bolts.....per pound..	.03
Filling stone.....per cord..	5.50	Spikes.....do....	.04
Riprap stone.....do....	5.50	S. and W. bolts.....do....	.04

Work in progress. Time for completion of contract September 30, 1887.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO PORT CLINTON HARBOR, OHIO.

[Prepared in compliance with circular letters from the Office of the Chief of Engineers, U. S. Army, dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June, 30, 1887.....	$46,018.50
Estimated amount required to complete the improvement.....	42,000.00
Approximate annual cost of preserving and maintaining.....	2,000.00

The available depth for navigation in 1872, when the work of improvement began, was 6 feet. This port had no commerce at that time.

The available depth for navigation is now 10 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected was not reported by collector.

Imports and exports not reported.

Fifty-four vessels, with an aggregate tonnage of 2,896 tons, entered, and forty-eight vessels, with an aggregate tonnage of 2,560 tons, cleared, from and for harbors in other districts.

Of vessels entering, the largest cargo was 400,000 feet of lumber, and the deepest draught was 10 feet. Of vessels clearing, the largest cargo was 12,000 bushels of wheat, and the deepest draught was 9½ feet.

The work of improvement thus far executed has had a very desirable effect upon manufacturing interests and the public interests in general.

By the completion of the proposed improvement commerce would be benefited only to the extent of an increased channel-entrance, but it would not be liable to attract additional commerce to the harbor. The community would be indirectly benefited by the expenditure and by a better harbor.

L L 4.

IMPROVEMENT OF SANDUSKY CITY HARBOR, OHIO.

Sandusky Bay empties into Lake Erie about 40 miles from its western extremity. It is a natural harbor, containing an area of about 22½ miles, with a depth of from 8 to 12 feet, protected on the north and northwest from the gales of the lake by a long narrow peninsula, and on the northeast by what is known as Cedar Point. A full description of the operations carried on in past years for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The present project, adopted in 1880, provides for a channel 200 feet wide and 15 feet deep through the outer bar, and in the bay up to within 50 feet of the line of docks, and then parallel to the docks, with a width of 100 feet and depth of 15 feet.

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OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the fiscal year there was only an available balance of $231.71. No work was in progress nor were any contracts in force.

The act of July 5, 1884, appropriated $20,000 for this harbor, only one-half of which ($10,000) was decided as available; the other half was appropriated for "repairs to existing works," and this $10,000 was on hand, though not available.

The act approved August 5, 1886, made the $10,000 "for repairs" available and made further appropriation of $5,000, giving a total of $15,000 for the fiscal year 1886–'87.

A project for the expenditure of these funds was submitted and approved, and proposals invited for doing the dredging. A contract was executed with Carkin, Stickney & Cram, of East Saginaw, Mich., dated October 15, 1886, for dredging 90,000 cubic yards, more or less, at 15 cents per cubic yard, scow measurement.

Operations were commenced with but one dredge in November and continued with numerous delays until close of month, when work was suspended for the season. Work was resumed in April, 1887, and continued until the close of the fiscal year. The progress was very slow, and by June 20, 1887, when contract should have been completed, only about one-eighth of the required dredging had been done. The contractors applied for and obtained an extension of time in which to complete their contract until September 30, 1887.

At the beginning of the fiscal year, 1887, there was a fairly good channel, with least depth of 14 feet, but not of full width through all the ranges. The condition of the channel was not so good as at the close of the season of 1886, showing no advance in the proposed improvement over the annual filling in. The outer bar needs most attention where the full width has as yet not been obtained on account of the small appropriations. For the various reasons given no progress toward the improvement of this harbor was practicable during the fiscal year ending June 30, 1887.

The total amount appropriated for this harbor to close of fiscal year has been $270,080, of which sum $257,327.08 has been expended.

It is estimated that $20,000 will be required to complete the present project, the whole of which can be expended during the fiscal year ending June 30, 1889. With increase of commerce at Sandusky an increase to 16 feet in depth of channel is needed to make it correspond with other important harbors on Lake Erie and with depth now carried through the St. Clair Flats Canal. This increased depth, it is estimated, would cost $61,000 additional, making $81,000 required for this harbor, of which sum $60,000 can be expended by the close of the fiscal year ending June 30, 1889. Like all the lake harbors where a dredged channel is the method of improvement, the annual expenditure must be a large one to maintain the channel and remove the material which the winter and spring storms wash into the channel.

The total amount expended on this harbor during the fiscal year ending June 30, 1887, was $2,478.79.

The act of August 5, 1886, under the head of "Examinations and Surveys," contained the following:

Sandusky Harbor, with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city.

Under date of February 2, 1887, I submitted a report of a survey for said straight channel, with estimate of cost of same. This report is printed in Senate Ex. Doc. No. 78, Forty-ninth Congress, second session, and I respectfully request that it may be republished in connec-

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tion with Annual Report for Sandusky Harbor for fiscal year ending June 30, 1887.

The river and harbor bill which passed both branches of the Forty-ninth Congress but failed to receive the signature of the President contained an appropriation for the straight channel. This work should be undertaken at once, and the necessary sum appropriated in one allotment.

An abstract of proposals and an abstract of contract are transmitted herewith:

Sandusky City Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range lights within the bay. Fort Wayne, below Detroit, is the nearest work of defense.

The amount of revenue collected during the fiscal year ending June 30, 1887, was $5,019.72 for the district, and $4,686.73 for the port of Sandusky.

The imports, consisting of fish, round timber, wood, etc., amounted in value to $53,640 for the district and to $47,316 for the port of Sandusky.

The exports, consisting of grain, coal, provisions, produce, etc., amounted in value to $239,587.27 for the district and $165,140.27 for the port of Sandusky for the fiscal year ending June 30, 1887.

The number of vessels entering was, for the district, 3,585, with an aggregate tonnage of 571,831 tons; for the port of Sandusky, 2,619, with an aggregate tonnage of 407,087 tons, during the fiscal year ending June 30, 1887.

The number of vessels clearing was, for the district, 3,605, with an aggregate tonnage of 569,359 tons; for the port of Sandusky, 2,611, with an aggregate tonnage of 407,849 tons, during the fiscal year ending June 30, 1887.

During the fiscal year ending June 30, 1887, of the vessels entering, the largest cargo was 2,589 gross tons of iron ore, and the deepest draught was 15½ feet; of the vessels clearing, the largest cargo was 1,600 tons of coal, and the deepest draught was 15½ feet.

Money statement.

July 1, 1886, amount available		$231.71
Amount appropriated by act approved August 5, 1886		15,000.00
		15,231.71
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$1,478.79	
July 1, 1887, outstanding liabilities	1,415.58	
		2,894.37
July 1, 1887, amount available		12,337.34
Amount (estimated) required for completion of existing project		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging 100,000 *cubic yards, more or less, from the channel through Sandusky Bay, at Sandusky City Harbor, Ohio, received and opened by Maj. L. Cooper Overman, Corps of Engineers, at* 11 *o'clock a. m., Tuesday September* 28, 1886, *under advertisement of September* 8, 1886.

No.	Names and addresses of bidder.	Price bid per cubic yard, scow measurement.	
		For 50,000 cubic yards.	For all the excavation.
		Cents.	*Cents.*
1	L. P. & J. A. Smith, Cleveland, Ohio	29½	29½
2	W. J. Starkweather, Cleveland, Ohio	30	30
3	Stang & Gillmore, Lorain, Ohio	29½	.....
4	*Carkin, Stickney & Cram, East Saginaw, Mich	20	15
5	Geo. Talbot, Buffalo, N. Y	30	30
6	E. H. French, Fulton, N. Y	30	.....

*Lowest bid for all the excavation required.

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Recommend that award be made to Carkin, Stickney & Cram, of East Saginaw, Mich, at the rate of 15 cents per cubic yard, scow measurement, for all the excavation.

ABSTRACT OF CONTRACT FOR IMPROVING HARBOR AT SANDUSKY, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

Contract with Carkin, Stickney & Cram, of East Saginaw, Mich., for dredging 93,000 cubic yards, more or less, of material from channel through Sandusky Bay. Contract dated October 15, 1886.

Contract time for completion extended to September 30, 1887.

Rate paid, 15 cents per cubic yard, scow measurement.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO SANDUSKY CITY HARBOR, OHIO.

[Prepared in compliance with circular letters from the Office of the Chief of Engineers, U. S. Army dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$256,327.08
Estimated amount required to complete the improvement	61,000.00
Approximate annual cost of preserving and maintaining	5,000.00

The available depth for navigation in 1844, when work of improvement was begun, was 10 feet.

The commerce at that time is unknown.

The available depth for navigation is now 15 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected for the district, $5,019.72; for the port of Sandusky, $4,686.73.

The imports, consisting of fish, round timber, wood, etc., amounted in value to $53,640 for the district and to $47,316 for the port of Sandusky.

The exports, consisting of grain, coal, provisions, produce, etc., amounted in value to $239,587.27 for the district and to $165,140.27 for the port of Sandusky.

The number of vessels entered for the district was 3,585; their aggregate tonnage was 571,831 tons. The number of vessels entered for the port was 2,619, and their aggregate tonnage was 407,087 tons.

The number of vessels cleared in the district was 3,605, and their tonnage was 569,359 tons. The number cleared for the port was 2,611; their tonnage was 407,849 tons.

Of the vessels entering, the largest cargo was 2,589 gross tons of iron ore, and the deepest draught was 15½ feet.

Of the vessels clearing, the largest cargo was 1,600 tons of coal, and the deepest draught was 15½ feet.

The work of improvement thus far executed has had a material effect in the reduction of rates of freight and insurance and in lessening the cost of transportation by competing routes.

The completion of the proposed improvement would be of great benefit to the community and is of daily and pressing importance to commerce.

L L 5.

IMPROVEMENT OF SANDUSKY RIVER, OHIO.

The Sandusky River rises in Richland County, Ohio, and after a very circuitous course empties into Sandusky Bay about 14½ miles from Cedar Point, where bay empties into Lake Erie.

Fremont, the head of navigation, is 17 miles from the mouth of the river. It is a city of about 9,000 inhabitants, and the market place of a large and productive surrounding country.

A history of the work carried on in past years for the improvement of the river will be found in Annual Report for 1881.

The present project, adopted in 1880, provides for dredging a channel

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100 feet wide and 9 feet deep through the various bars between the city of Fremont and the depth of 9 feet in Sandusky Bay.

The officer in charge, in his annual report for 1882, since which date there has been no work for the improvement of this river, writes as follows:

I am satisfied that but little difficulty will be experienced in keeping open at all times a good channel, with a depth of 9 feet, between Fremont and the mouth of the river; but the character of the materials comprising the outer bar is such that I deem it exceedingly doubtful whether the channel lately dredged through it will remain open for any length of time. I feel sure that no permanent improvement can be maintained without an elaborate system of dikes, the expense of which would not be warranted by the present limited commerce of the port.

OPERATIONS DURING THE FISCAL YEAR.

Balance of appropriation under act of August 2, 1882, at beginning of fiscal year was $628.47. No further appropriation has been made since. The amount on hand was too small to attempt any new work, and was reserved for some contingency pending further appropriations.

No work was done during the fiscal year. There have been no complaints from vessel-men as to the condition of the channel nor requests for additional improvements; hence it is assumed that the river in present condition answers all demands of the commerce navigating it.

The estimated cost of the present project is $44,000. Of this amount $21,500 has been appropriated; $10,000 can be expended during the period ending June 30, 1889.

Total amount appropriated for this river to date is $51,500, of which sum $50,871.53 has been expended.

The last river and harbor bill (act of August 5, 1886) made no appropriation of funds for this river; hence no work was done during the fiscal year ending June 30, 1887.

Fremont, the head of navigation, is in the collection district of Sandusky, Ohio. The nearest light-house is at Cedar Point, the entrance to Sandusky Bay.

Fort Wayne, near Detroit, Mich., is the nearest work of defense.

There were no revenue collections, no imports, and no exports for the fiscal year ending June 30, 1887, for this port.

Money statement.

July 1, 1886, amount available	$628.47
July 1, 1887, amount available	628.47
Amount (estimated) required for completion of existing project	22,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

STATEMENT OF STATISTICS AND INFORMATION RELATING TO SANDUSKY RIVER, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. Army, dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$50,871.53
Amount estimated as required to complete improvement	22,500.00
Approximate annual cost of preserving and maintaining	3,000.00

The available depth for navigation in 1867, when work of improvement was begun, was 5 feet.

The commerce at that time is unknown.

The available depth for navigation is now 9 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

There was no revenue collected.

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There were no imports nor exports.

The collector in his report did not state the number of vessels entering and clearing.

The work of improvement thus far executed has had no effect on rates of freight and insurance. The commerce has declined with increased railroad facilities.

The completion of the proposed improvement would be a benefit to commerce only to the extent of an increased channel entrance, but it would not be liable to attract additional commerce to the port.

The community would be indirectly benefited by the expenditure and by a better channel.

L L 6.

IMPROVEMENT OF HURON HARBOR, OHIO.

The Huron River rises in the northern part of Ohio, and after a very circuitous course empties into Lake Erie about 10 miles east of Sandusky City.

For a history of the operations carried on in past years for the improvement of this harbor see the Annual Reports of 1880, 1881, and 1883.

The project for the improvement of this harbor, adopted in 1886, when the mouth of the river was closed by a sand-bar, and which project has been amended from time to time, as the demand of commerce called for an increased depth of channel, consists of parallel piers, 140 feet apart, extending to a depth of 14 feet in the lake.

OPERATIONS FOR THE FISCAL YEAR.

The act approved August 5, 1886, made an appropriation of $3,000 for this harbor; dredging and repairs were recommended as the necessary work with the funds.

A contract was made with Stang & Gillmore, of Lorain, Ohio, dated September 11, 1886, for dredging 5,000 cubic yards of material from between piers, and from bar in lake beyond end of piers, at the rate of 25 cents per cubic yard, pla e measurement, for dredging from between piers, and 26 cents per cubic yard, place measurement, for dredging from bar in lake. Work was begun October 2, and completed October 20, 1886, as the funds allotted for the dredging were exhausted. But 4,147 cubic yards were removed, of which 2,150 cubic yards were from off the bar and 1,997 cubic yards from between the piers. Further dredging could have been done to the material improvement of the channel, but funds were wanting.

A contract was made with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 9, 1886, for the repair of the piers. Work was begun October 11, and continued, with some interruptions, until December 9, 1886, when operations were suspended on account of the exhaustion of the appropriation. Only the most pressing of the necessary repair work could be done with the small amount of funds available. So much was needed that only "patching up" could be undertaken.

The east pier is in a very bad condition and unless extensive repairs are soon made it is liable to fall into and close the channel.

Both piers need extensive repairs, and an extension of the piers should be made to gain increased channel depth.

The entire amount appropriated to date (June 30, 1887) for this harbor has been $117,273.71, all of which has been expended and has given a good channel with 15 feet depth at low water until piers became so badly destroyed.

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An examination of the channel of this harbor was made in June, 1887, and showed a fair channel, with least depth of 16 feet, and in such condition that a little work would secure a channel depth of 17 feet.

As Huron is one of the best natural harbors on Lake Erie, it will be proper, if the commerce of Huron increases, to extend the pier out to the 16-foot curve in the lake.

The Wheeling and Lake Erie Railroad Company have expended considerable for docks and slips at this harbor, with view to shipment of coal, etc. The records of the custom-house, however, show that at present the amount of commerce to be benefited by further improvements at this harbor is small.

The estimated cost of renewing the superstructure of the piers was $22,000; $16.500 has been appropriated, but owing to the extra repairs made necessary by the storms of 1884, 1885, and 1886 the estimate to complete the renewals should be $17,000, rather than the remaining balance of $5,500, which increased amount can be expended during fiscal year ending June 30, 1889, in rebuilding superstructure, repairing piers, etc.

An abstract of proposals and an abstract of contracts are transmitted herewith.

Huron Harbor is in the collection district of Sandusky, Ohio. Fort Wayne, Mich. about 70 miles distant, is the nearest work of defense. There is a fixed white light of the fourth order on the outer end of the west pier.

During the fiscal year ending June 30, 1887, the amount of revenue collected was $177.30.

The imports, consisting of iron ore, hard coal, lumber, stone, lathes, hay, and salt, amounted in value to $326,685.50.

The exports, consisting of coal, wheat, and oats, amounted in value to $123,120.

One hundred and ninety-seven vessels, with an aggregate tonnage of 56,872 tons, entered; and 206 vessels, with an aggregate tonnage of 54,956 tons, cleared.

Of vessels entering or clearing, the largest cargo was 1,840 tons of iron ore, and the deepest draught was 14½ feet.

Money statement.

July 1, 1886, amount available	$208.99
Amount appropriated by act approved August 5, 1886	3,000.00
	3,208.99
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,208.99
Amount (estimated) required for completion of existing project	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	12,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging 5,000 cubic yards, more or less, from channel of Huron Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Friday, September 3, 1886, under advertisement dated August 18, 1886.]

No.	Name and address of bidders.	Price bid per cubic yard.		
		From channel, inside.	From bar in lake.	For all the excavation.
		Cents.	*Cents.*	*Cents.*
1	L. P. & J. A. Smith, Cleveland, Ohio	†29	†29	†29
2	James Rooney, Toledo, Ohio	.....	.....	†24
3	Edwin H. French, Fulton, N. Y	†28	†30	.....
4	Stang & Gillmore, Lorain, Ohio*	‡25	‡28	‡36

* Lowest bid on basis of place measurement. † Scow measurement. ‡ Scow or place measurement.

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Recommend that award be made to Stang & Gillmore, of Lorain, Ohio, at the rate of 25 cents per cubic yard, place measurement, per inside dredging, and 26 cents per cubic yard, place measurement, for outside dredging.

Abstract of proposals for furnishing the materials and doing the work for repairs, etc., at Huron Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock, a. m., Monday, September 27, 1886, under advertisement dated August 20, 1886.]

Material.	1. Stang & Gillmore, Lorain, Ohio.	2. L. P. & J. A. Smith, Cleveland, Ohio.*
White pine, 24,688 feet, B. M.....per M feet, B. M..	$36.00	$35.00
White oak, 14,629 feet, B.M .....do.....	42.00	40.00
Piles, 2,916 linear feet .....per linear foot..	.38	.35
Brush, 10 cords .....per cord..	3.00	3.00
Riprap stone .....do.....	5.00	4.50
Filling stone, 10 cords.....do.....	5.00	5.00
Spikes, 900 pounds .....per pound..	.04	.04
S. and W. bolts, 2,655 pounds.....do	.04	.04
Drift-bolts, 800 pounds .....do.....	.04	.03
Total.....	2,865.45	2,716.04

* Lowest bid and considered reasonable.

Recommend that award be made to Messrs. L. P. & A. J. Smith at the prices named in their proposal.

ABSTRACT OF CONTRACTS FOR IMPROVING HARBOR AT HURON, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(1) Contract with Stang & Gillmore, of Lorain, Ohio, dated September 11, 1886, for dredging 5,000 cubic yards, more or less, of material from channel of Huron Harbor, Ohio.

Rate paid: For dredging from channel through bar in lake, 26 cents per cubic yard, place measurement; for dredging from channel between piers, 25 cents per cubic yard, place measurement.

Contract time for completion extended to October 30, 1886.

Contract completed and closed.

(2) *Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 9, 1886, for repairs, etc., to piers at Huron Harbor, Ohio.*

Material.	Rate.	Material	Rate.
White pine.....per M feet, B. M..	$35.00	Riprap .....per cord..	$4.50
White oak .....do....	40.00	Spike.....per pound..	.04
Piles.....per linear foot..	.35	S. and W. bolts.....do....	.04
Brush.....per cord..	3.00	Drift-bolts .....do....	.03
Filling stone .....do....	5.00		

Contract completed and closed.

Statement of statistics and information relating to Huron Harbor, Ohio.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. Army, dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$117,273.71
Estimated amount required to complete the improvement.....	22,000.00
Approximate annual cost of preserving and maintaining	2,000.00

The available depth for navigation in 1827, when the work of improvement was begun, was 1 foot, and at which time the port had very little commerce.

The available depth is now 15½ feet.

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The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected	$177.30
The imports, consisting of iron ore, hard coal, lumber, stone, lath, hay, and salt, amounted in value to	326,685.50
The exports, consisting of coal, wheat, and oats, amounted in value to	123,120.00

One hundred and ninety-seven vessels, with an aggregate tonnage of 56,872 tons, entered; and 206 vessels, with an aggregate tonnage of 54,956 tons, cleared. Of vessels entering, the largest cargo was 1,840 tons of iron ore, and the deepest draught was 14½ feet. Of the vessels clearing, the largest cargo was 1,550 tons of coal and the deepest draught was 14 feet.

The improvement of this harbor has been the means of a large reduction in freight rates and an increase of 1,000 per cent. in the business of the harbor. It has had no material effect on insurance.

By the completion of the proposed improvement this harbor would be made second to none on Lake Erie. It would result in great advantage and benefit to the community.

L L 7.

IMPROVEMENT OF VERMILLION HARBOR, OHIO.

The Vermillion River rises in the northern part of Ohio and empties into Lake Erie about 20 miles to the eastward of Sandusky City.

A history of the operations carried on in the past years for the improvement of this harbor will be found in annual reports of 1880 and 1881.

The project of improvement which was adopted in 1836, when there was a depth of less than 2 feet of water on the bar at the entrance, and which project has been amended from time to time as the requirements of commerce demanded deeper water, consists of parallel piers 125 feet apart, running out to a depth of 12 feet in the lake.

OPERATIONS FOR THE FISCAL YEAR.

At the opening of the fiscal year there was a balance on hand of $758.68 for this harbor. The act approved August 5, 1886, appropriated $3,000 for this harbor.

A contract for repairs was made, under date of October 28, 1886, with Messrs. L. P. & J. A. Smith, of Cleveland, Ohio.

Work was at once undertaken and continued until December 30, 1886, when unfavorable weather and the near exhaustion of the appropriation caused a suspension of the work and contract was closed.

Both piers were put in fair condition considering the small amount available for the work. The sum of $3,450.50 was expended in materials, labor, and superintendence.

An examination of the channel for this harbor was made in June, 1887, which showed that there was a good channel with least depth of 12 feet from lake to town landing.

The proposed project for this harbor provides for opening a channel 100 feet wide and 14 feet deep from lake to the lower end of the docks at Vermillion, this channel to be secured by removing about 2,000 cubic yards of rock and about 25,000 cubic yards of gravel, sand, shale, etc., at an estimated cost of $15,000. The piers need further repairs, estimated to cost $2,000, making a total of $17,000 for the project.

The sand is steadily encroaching around the ends of the piers into the channel, and to arrest its progress it will be necessary to extend the piers, say, 500 feet further into the lake, at a cost of about $70,000.

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With the present limited commerce of Vermillion, such an expenditure is not advisable.

As but $6,000 of the estimated $17,000 for proposed project has been appropriated, and $5,691.82 of it expended in repairs, it is doubtful whether anything but the keeping of the existing construction in good condition should be undertaken until an increase of commerce shall require an increase of channel depth.

The total amount appropriated for this harbor to June 30, 1887, is $117,942.32, of which sum $117,634.14 has been expended.

An abstract of proposals and an abstract of contract are transmitted herewith.

Vermillion Harbor is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier. Fort Wayne, Mich., 80 miles distant, is the nearest work of defense.

During the fiscal year ending June 30, 1887, the amount of revenue collected was $2.

The imports, consisting of lumber and fish, amounted in value to $40,000. The exports, consisting of lumber and fish, amounted in value to $5,000.

Eleven vessels, with an aggregate tonnage of 6,300 tons, entered; and 13 vessels, with an aggregate tonnage of 960 tons, cleared. Exports shipped by raft.

Of the vessels entering or clearing, the largest cargo was 350,000 feet of lumber, and the deepest draught was 12 feet.

Money statement.

July 1, 1886, amount available	$758.68
Amount appropriated by act approved August 5, 1886	3,000.00
	3,758.68
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,450.50
July 1, 1887, amount available	308.18
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for furnishing the materials and doing the work for repairs, etc., at Vermillion, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Monday, September 27, 1886, under advertisement dated August 20, 1886.]

Material.	1. Stang & Gillmore, Loraine, Ohio.	2. L. P. & J. A. Smith, Cleveland, Ohio.*
White pine, 85,140 feet, B. M.....per M. feet, B M..	$34.50	$32.00
White oak, 4,687 feet, B. M.....do....	35.00	40.00
Piles, 384 feet.....per linear foot..	.50	.50
Brush.....per cord..	.....	3.00
Filling stone, 20 cords.....do....	5.50	6.00
Riprap.....do....	.....	5.00
Spikes, 2,000 pounds.....per pound..	.04	.03
S. and W. bolts, 820 pounds.....do....	.04	.04
Drift-bolts, 500 pounds.....do....	.03	.03
Total	3,531.17	3,331.76

* Lowest bid reasonable when quantity is considered.

Recommend that award be made to Messrs. L. P. & J. A. Smith, of Cleveland, Ohio, at prices named in their proposal.

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Abstract of contract for improving harbor at Vermillion, Ohio, in force during the fiscal year ending June 30, 1887.

[Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 28, 1886, for repairs, etc., to piers at Vermillion Harbor, Ohio.]

Material.	Rate.	Material.	Rate.
White pine.....per M feet, B. M	$32.00	Riprap ..... per cord	$5.00
White oak .....do	40.00	Spikes .....per pound	.03
Piles .....per linear foot	.50	S and W. bolts .....do	.04
Brush .....per cord	3.00	Drift-bolts .....do	.03
Filling stone .....do	6.00		

Contract completed and closed.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO VERMILLION HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. Army, dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$117,634.14
Estimated amount required to complete the improvement	14,000.00
Approximate annual cost of preserving and maintaining	2,000.00

The available depth for navigation in 1836, when the work of improvement was begun, was 1½ feet.

No commerce at that time.

The available depth for navigation is now 12 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected	$2.00
The imports, consisting of lumber and fish, amounted in value to	40,000.00
The exports, consisting of round timber, amounted in value to	5,000.00

Eleven vessels, with an aggregate tonnage of 6,300 tons, entered; and 13 vessels, with an aggregate tonnage of 960 tons, cleared.

Of the vessels entering, the largest cargo was 350,000 feet of lumber, and the deepest draught was 12 feet.

All vessels cleared light. Exports shipped by raft.

The effect of work thus far executed upon rates of freight and insurance and upon rates of competing routes of transportation "has been beneficial."

The completion of the proposed improvement will result in great benefit to the community, and will be an advantage to commerce. Vermillion is valuable as a winter harbor, as much repairing of vessels is done there.

L L 8.

IMPROVEMENT OF HARBOR AT MOUTH OF BLACK RIVER, OHIO.

Black River, Ohio, is formed by two branches, nearly equal in size, which, rising in Lorain County, Ohio, and flowing northward, unite about 8 miles from the town of Lorain, where the river empties into Lake Erie.

A history of the operations carried on during the last fifty-four years, whereby the depth at the entrance to this harbor has been increased from about 3 feet to at least 16 feet, will be found in Annual Reports of 1880 and 1881.

The project of improvement submitted in 1828, and amended from time to time, as the demands of commerce called for an increased depth in channel, consists of parallel piers, 200 feet apart, running out from the shore on each side of the mouth of the river to a depth of 16 feet in the lake.

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OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the fiscal year there were no contracts in force, nor was there any work in progress, funds being entirely exhausted.

In April, 1886, it was reported that the bar had again formed near end of piers. As there were no funds available, no steps could be taken for its removal.

The act approved August 5, 1886, appropriated $10,000 for this harbor.

As dredging was badly needed, a contract was entered into as soon as possible for the excavation from channel. Contract was executed September 11, 1886, with Stang & Gillmore, of Lorain, Ohio. Operations were commenced September 16, 1886, and continued, with some slight interruptions, until September 29, 1886, when contract was closed. About 3,994 cubic yards of material was removed, at a cost of $1,018.47, which restored a good 16-foot depth to channel from lake to ore-docks.

As the storms of the previous season had done considerable damage to both piers, especially the east pier, proposals were invited for repairing same as far as available funds would permit. A contract was executed with Stang & Gillmore, of Lorain, Ohio, dated October 11, 1886, for the necessary repairs.

Work was not commenced till November 1, 1886, and had to be suspended December 11, 1886, on account of the ice and snow. Operations were resumed May 15, 1887, and were continued until the close of the fiscal year, when the work was about seven-eighths finished. The time for completion of contract was extended until July 30, 1887, at which time it is expected the work will be completed and the appropriation exhausted.

The storms of the past year have done considerable damage to both piers, especially the east pier, and this pier is so badly deteriorated as to require renewal above low-water surface for about two-thirds of its length. The piers are badly in need of renewal and extension.

The present project provides for prolonging the west pier 180 feet and the east pier 120 feet, and of renewing about 200 linear feet of superstructure, at an estimated cost of $45,000. Of this amount, $37,000 has already been appropriated, but unexpected repairs, made and to be made, will make it necessary to still provide about $30,000 for completion of the existing project, all of which can be expended during the fiscal year ending June 30, 1889, in prolonging the piers and renewing the superstructure. The total amount appropriated for this harbor to date, June 30, 1887, is $220,138.73, all of which will be expended by August 30, 1887, and with which a good 16-foot channel has been obtained.

The commerce of this harbor is increasing, and it is therefore important that the proposed extension of piers should be carried out at as early a day as possible, to prevent a recurrence of the shoaling at the entrance of harbor.

The whole amount required ($30,000) should be appropriated in one allotment, and it could be profitably expended during the fiscal year ending June 30, 1889.

An abstract of proposals and an abstract of contracts are transmitted herewith.

Black River is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order at the outer end of the west pier. The nearest work of defense is Fort Wayne, Mich., 80 miles distant.

For the fiscal year ending June 30, 1887, the imports, consisting of iron ore, lumber, limestone, salt, etc., amounted in value to $840,736. The exports, consisting of coal, amounted to $378,330.

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Two hundred and fifty-nine vessels, with an aggregate tonnage of 84,593 tons, entered, and 286 vessels, with an aggregate tonnage of 89,498 tons, cleared during the fiscal year ending June 30, 1887.

Of the vessels entering or clearing the largest cargo was 2,400 tons of iron ore, and the deepest was 15½ feet.

The commerce of this port is increasing and the harbor is destined to take high rank with the others on the lakes; its trade in coal and iron is daily becoming more valuable. It is the lake terminus of the Cleveland, Lorain and Wheeling Railroad, which has direct connection with the Ohio River.

Money statement.

Amount appropriated by act approved August 5, 1886		$10,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,090.26	
July 1, 1887, outstanding liabilities	410.75	
		4,501.01
July 1, 1887, amount available		5,498.99
Amount (estimated) required for completion of existing project		20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging 6,000 cubic yards, more or less, from channel at Black River Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Friday, September 3, 1886, under advertisement dated August 18, 1886.]

No.	Name and address of bidders.	Price bid per cubic yard.		
		From channel inside.	From bar in lake.	For all the excavation.
		Cents.	*Cents.*	*Cents.*
1	L. P. & J. A. Smith, Cleveland, Ohio*	29	29	29
2	James Rooney, Toledo, Ohio*	.....	.....	24
3	Wm. J. Starkweather, Cleveland, Ohio*	.....	.....	29
4	Edwin H. French, Fulton, N. Y.†	30	30	.....
5	Stang & Gillmore, Lorain, Ohio‡	25	26	25¼

* Scow measurement. † Place measurement. ‡ Scow or place measurement; lowest bid on basis of place measurement.

Recommend that award be made to Stang & Gillmore, of Lorain, Ohio, at the rate of 25¼ cents per cubic yard, place measurement, for *all* the dredging.

Abstract of proposals for furnishing the materials and doing the work for repairs, etc., at Black River Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Monday, September 27, 1886, under advertisement dated August 20, 1886.]

Material.		1. Stang & Gillmore Lorain, Ohio.*	2. L. P. & J. A. Smith, Cleveland, Ohio.
White pine, 162,474 feet, B. M.	per M feet, B. M.	$31.90	$32.00
White oak, 17,600 feet, B. M.	do	34.90	40.00
Piles, 2,022 linear feet	per linear foot	.34½	.35
Brush, 40 cords	rate per cord	3.00	3.00
Filling stone, 150 cords	do	5.00	5.50
Riprap	do	4.50	5.00
Spike, 1,165 pounds	rate per pound	.04	.04
S. and W. bolts, 1,139 pounds	do	.04	.04
Drift-bolts, 6,400 pounds	do	.03	.04
Total		7,648.91	7,904.02

* Lowest bid, and considered reasonable.

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Recommend that award be made to Messrs. Stang & Gillmore, of Lorain, Ohio, at prices named in their proposal.

ABSTRACT OF CONTRACTS FOR IMPROVING HARBOR AT BLACK RIVER, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(1) Contract with Stang & Gillmore, of Lorain, Ohio, dated September 11, 1886, for dredging 6,000 cubic yards, more or less, of material from channel at Black River Harbor, Ohio.

Rate paid, 25½ cents per cubic yard, place measurement.

Contract completed and closed.

(2) *Contract with Stang & Gillmore, of Lorain, Ohio, dated October* 11, 1886, *for repairs, etc., to piers at Black River Harbor, Ohio.*

Material.	Rate.	Material.	Rate.
White pine..... per M feet, B. M..	$31.90	Riprap ..... per cord..	$4.50
White oak ....do....	34.90	Spike ....per pound..	.04
Piles .....per linear foot..	.34½	S. and W. bolts ....do....	.04
Brush.....per cord..	3.00	Drift-bolts .....do....	.03
Filling stone .....do....	5.00		

Contract completed and closed.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO BLACK RIVER HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. A., dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887.....	$214,228.99
Estimated amount required to complete improvement.....	20,000.00
Approximate annual cost of preserving and maintaining.....	2,000.00

The available depth for navigation in 1828, when work of improvement was begun was 3 feet.

The commerce at that time is unknown.

The available depth for navigation is now 16 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

The imports, consisting of iron ore, lumber, limestone, salt, etc., amounted in value to.....	$840,736
The exports, consisting of coal, amounted in value to.....	378,330

Two hundred and fifty-nine vessels, with an aggregate tonnage of 84,593 tons entered, and 286 vessels, with an aggregate tonnage of 89,498 tons, cleared.

The largest cargo of vessels entering was 2,407 tons of iron ore. The largest cargo of vessels clearing was 2,250 tons of coal.

The deepest draught of vessels clearing was 15 $\frac{8}{12}$ feet.

The work of improvement, thus far executed, has had a material effect in the reduction of rates of freight and insurance.

The completion of the proposed improvement would be very advantageous to commerce, a great benefit to the community, and by its completion would be gained a harbor second to none on Lake Erie.

L L 9.

IMPROVEMENT OF MOUTH OF ROCKY RIVER, OHIO.

Rocky River rises in the northern part of Ohio, and, flowing north, empties into Lake Erie about 5 miles west of Cleveland.

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A history of the operations heretofore carried on at this place under various acts of Congress will be found in the Annual Reports of the Chief of Engineers for 1880 and 1881.

The violent storms of the springs of 1884, 1885, 1886, and 1887 did considerable damage to the pier at this harbor.

OPERATIONS FOR THE FISCAL YEAR.

Balance on hand at beginning of the fiscal year of appropriation under act of June 14, 1880, was $113.87, and no further appropriation was made during the fiscal year. No work done during the fiscal year for want of funds. The mouth of Rocky River is not a port; it has no commerce, and any expenditure of funds for its improvement beyond necessary repairs to the existing pier is not deemed advisable.

The Cleveland harbor of refuge is only 5 miles distant. An appropriation of $3,000 for repairs is all that is required at present. The total amount appropriated for the river mouth to present date has been $39,000, of which sum $38,880.69 has been expended.

An examination of the river made in October, 1883, showed that there was a fair channel 150 feet wide, with least depth of 7 feet from lake to head of Island No. 1 inside the pier; all that the commerce of the river calls for.

The last river and harbor bill (act of August 5, 1886), made no appropriation of funds for this harbor, hence no repairs were made during the fiscal year ending June 30, 1887, and this delay has increased the amount of repairs now necessary.

The nearest light-house is at Cleveland. The nearest work of defense is at Fort Wayne, Mich., 106 miles distant.

Money statement.

July 1, 1886, amount available	$131.87
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	12.56
July 1, 1887, amount available	119.31
Amount that can be profitably expended in repairs in fiscal year ending June 30, 1889. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	4,000.00

STATEMENT OF STATISTICS AND INFORMATION RELATING TO ROCKY RIVER HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. A., dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$38,880.69
Approximate annual cost of preserving and maintaining	1,000.00

The available depth for navigation in 1873, when work of improvement was begun, was 4 feet.

The available depth for navigation is now 8 feet.

Rocky River is not a port and has no commerce.

The work thus far executed has had no effect upon rates of freight and insurance, etc.

No practical benefit would be derived from the completion of the proposed improvement.

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L L 10.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

Cleveland, Ohio, is situated at the mouth of the Cuyahoga River. This river rises in the northern part of Ohio, and after a very circuitous course empties into Lake Erie. A description of the operations carried on in past years for the improvement of this harbor will be found in Annual Reports of 1880 and 1881.

The original project of improvement adopted in 1825, when there was a depth of only 3 feet in the narrow and crooked channel at the entrance, and which project has been amended from time to time as the demands of commerce called for an increased depth of water, provides for parallel piers 200 feet apart, running out to a depth of 16 feet in the lake. This project is completed.

In 1875, in accordance with an act of Congress, a plan was submitted for a harbor of refuge at this place.

This plan, which, after amendment by the Chief of Engineers, was approved by the Secretary of War, provided for an outer breakwater in a depth of about 5 fathoms, connected at its west end with the main shore. The entrance near the east end was to be protected by extending the west pier at the mouth of the river, "according to original plan."

The original project of the Board of Engineers provided for prolonging the west pier, but such earnest protests were made against this by parties interested in commerce, and such urgent appeals made for the extension of the east pier instead, that the honorable Secretary of War, before whom these facts were placed, decided to comply with the wishes of the mariners, and has directed that the east, instead of the west, should be prolonged.

This plan has been still further amended by project for an additional breakwater, extending on the east side of the opening between the piers.

The shore arm of the west breakwater starts from a point about 700 feet west of the extremity of the old bed of the Cuyahoga River and runs out into the lake, in a direction nearly due north, a distance of 3,130 feet.

The lake arm, which is about parallel with the main shore, is 4,030 feet long, and a point 200 feet from its eastern extremity a spur 100 feet long runs out at right angles, so as to break the force of the heavy sea rolling along the breakwater during westerly and northwesterly gales.

All this portion was completed in December, 1883.

The proposed east breakwater begins at a point on the prolongation of the lake arm of the west breakwater and 500 feet from it; extends eastward on this line about 1,100 feet; then inclines toward the shore, and extends 2,400 feet in a depth of 25 feet of water; and having between its eastern end and the curve of 14 feet depth of water an entrance 1,200 feet wide.

For the history of this change in plan for harbor of refuge, see Annual Reports of 1884, 1885, and 1886.

OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the fiscal year no work was in progress, nor were there any contracts in force.

The available balance of funds on hand was $87,001.86, of which no portion was available for the proposed east breakwater.

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The act approved August 5, 1886, relating to Cleveland Harbor, Ohio, reads as follows:

Improving harbor at Cleveland, Ohio, on the last plan projected, $93,750; of which $30,000 are to be used in building a parapet on the existing breakwater, and the $100,000 now on hand to be available for work on the last plan.

A project for the expenditure of these sums was submitted. Proposals were invited and opened October 18 for constructing about 1,200 linear feet of the foundation for the east breakwater. Contract was executed October 28, 1886, with Messrs. L. P. and J. A. Smith, of Cleveland, Ohio.

The work was commenced in November and continued during the remainder of the fiscal year when weather permitted. About 1,200 linear feet of foundation, requiring about 3,500 cords of stone, had been about seven-eighths finished by June 30, 1887, which was the date fixed for the completion of this part of the work. On account of the difficulty in obtaining vessels to carry the stone, the contractors were unable to complete the work; they, therefore, applied for and obtained an extension of time until September 1, 1887. The entire foundation required under this contract will doubtless be completed by the end of August, 1887.

Proposals were opened December 13, 1886, for constructing about 1,200 linear feet of the east breakwater and furnishing the iron for same. The contract for iron was awarded to Charles W. Scofield, of Cleveland, Ohio. The contract for materials, other than iron, and for the labor was awarded to Mr. Charles E. Williams, of Buffalo, N. Y. Mr. Williams failed to execute his bond or enter into contract, and the work was awarded to the next lowest bidders, Messrs. L. P. and J. A. Smith, of Cleveland, Ohio. A contract was at once made with them dated February 28, 1887.

Repairs to piers and breakwater were made at various times during the year by "hired labor and purchase in open market," the character and quantity of the work to be done making that system more economical and advantageous than contract method.

For this purpose the sum of $750 was expended during the fiscal year.

At the close of the fiscal year ending June 30, 1887, the piers were in fair repair and the breakwater in fair condition and withstanding well the action of the storms. Some slight repairs were needed to piers and breakwater, which will be commenced in August. There was a good 15½-foot channel between the piers and to deep water in the lake.

The cost of the proposed east breakwater, 3,500 feet long, was estimated to be about $440,000. The estimated cost of this harbor of refuge as originally projected and approved was $1,800,000. The amount expended up to the present time, the west breakwater being completed as originally designed, is $800,000. When the work now recommended is constructed the total cost of the harbor of refuge, under the project now approved, will be about $1,300,000, which is $500,000 less than the original estimate.

A Board of Engineers further recommended, in order that the harbor may completely fulfill the objects for which it was constructed, that a harbor-master be appointed and that a strong sea-going tug be employed during the season of navigation to tow in and place vessels which can not be handled by the river tugs.

A Board of Engineers also recommended the construction of a parapet, about 4 feet high and 16 feet wide on the present west breakwater, to prevent the pouring over into the harbor the large volume of water thrown therein during heavy gales, which it is asserted raises the level

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of the water within the harbor to such an extent as to produce a very strong current out of it at the entrance.

The cost of such a parapet would probably be about $60,000.

Proposals for constructing this parapet wall were opened May 10, 1887, and resulted in the execution of a contract with Mr. B. S. Horton, of Vermillion, Ohio, for the construction of about 4,000 linear feet for the available sum of $30,000. Work was commenced June 1, 1887, and continued until close of the fiscal year. The progress was fair, and it is hoped that the entire amount of work contracted for will be completed by the close of the year 1887.

The original estimate for the harbor of refuge was $1,800,000. About $800,000 has been expended, and five-sixths of the original plan completed. The proposed change of plan is estimated to cost $440,000, so that the harbor of refuge with an eastern breakwater can be completed for about $500,000 less than the original estimate.

The amount estimated as required for the completion of the approved change in project is $319,250, which sum should be appropriated in one allotment, and can be profitably expended during the fiscal year ending June 30, 1889.

The harbor of refuge, as now planned, will, when completed, be about 2 miles long, and offers an area of 300 acres for anchorage, the depth in 200 acres of which will be from 17 to 29 feet.

The total expenditure for the fiscal year ending June 30, 1887, including repairs, contingencies, etc., was $12,692.04. The total amount appropriated to July 1, 1887, for the harbor of refuge is $993,750, of which sum $821,898.32 has been expended to June 30, 1887, less about $34,750, expended in repairs to piers, dredging, etc., for Cleveland Harbor proper.

The river and harbor bill approved August 5, 1886, reads as follows, as relates to Cleveland Harbor:

Improving harbor at Cleveland, Ohio, on the last plan projected, $93,750; of which $30,000 are to be used in building a parapet on the existing breakwater, and the $100,000 now on hand to be available for work on the last plan.

Contracts for the expenditure of above funds have been made, and the work will be completed as soon as practicable. All funds will be expended (or contracted for) during the fiscal year ending June 30, 1888.

The parapet on the west breakwater will be constructed to the extent of the $30,000 by end of calendar year, and the greater part of the 1,200 linear feet of east breakwater (which is about the length of completed breakwater that $120,000 will pay for) will be in progress and half finished by December 30, 1887.

An "abstract of proposals" and an "abstract of contracts" are transmitted herewith:

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on shore and a beacon on the outer end of each pier, and a beacon on the independent crib just inside the east end of the lake-arm of the breakwater. The nearest work of defense is Fort Wayne, Mich., 110 miles distant.

The amount of revenue collected during the fiscal year ending June 30, 1887, was $299,330.60.

The imports, consisting of general merchandise, iron ore, lumber, coal, provisions and produce, amounted in value to $30,680,082. The exports, consisting of general merchandise, coal, iron, and oil, amounted in value to $46,501,153 during the fiscal year ending June 30, 1887.

Two thousand nine hundred and thirty-nine vessels, with an aggregate tonnage of 1,371,452 tons, entered; and 2,940 vessels, with an aggregate tonnage of 1,390,031 tons, cleared, during the fiscal year ending June 30, 1887. Of the vessels entering, the largest cargo was 2,504 tons of iron ore, and the deepest draught was 16 feet. Of the vessels clearing, the largest cargo was 2,700 tons of coal, and the deepest draught was 15½ feet.

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Money statement.

July 1, 1886, amount available		$87,001.86
Amount appropriated by act approved August 5, 1886		93,750.00
		180,751.86
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	12,692.04	
July 1, 1887, outstanding liabilities	2,136.84	
		14,828.88
July 1, 1887, amount available		165,922.98
Amount (estimated) required for completion of existing project		319,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		319,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing office supplies, stationery, hardware, paint, oil, etc., as may be required for use by the United States Engineer during the fiscal year ending June 30, 1887.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Monday, October 11, 1886, under advertisement dated September 20, 1886.]

No.	Name and address of bidder.	Aggregate of bid on— Stationery supplies. Bids for a minority of articles in schedule.	Stationery supplies. Bids for a mo n proportion of articles in schedule.	Stationery supplies. Bids for a majority of articles in schedule.	Iron, tools, hardware, wire, rope, paint, oils, etc. Bids for a minority of articles in schedule.	Iron, tools, hardware, wire, rope, paint, oils, etc. Bids for a majority of articles in schedule.
1	Short & Forman, Cleveland, Ohio*	$61.19	$89.62	$279.35	.....	.....
2	Brooks & Co., Cleveland, Ohio	72.00	101.80	268 67	.....	.....
3	A. T. Osborn & Co., Cleveland, Ohio	75.75	.....	.....	$57.22	.....
4	McIntosh, Good & Huntington, Cleveland, Ohio.†	62.50	91.40	.....	37.36	$148.07
5	J. C. Wilmot, Cleveland, Ohio	.....	.....	.....	54.10	.....
6	The Sturtevant Lumber Company, Cleveland, Ohio.‡	.....	.....	.....	.....	.....

* Lowest bid for mean of articles required, and but $10.68 higher in the aggregate of all articles.
† Lowest bid for hardware, etc.
‡ No regular bid received for lumber, this firm simply inclosing a general price-list.

Recommend that award be made to Messrs. Short & Forman for the stationery supplies, as per prices in their bid.

Recommend that award be made to Messrs. McIntosh, Good & Huntington for iron, hardware, paints, oils, etc., and same firm articles of drawing materials, as per prices in their bid.

Abstract of proposals for furnishing and placing 3,600 cords, more or less, of rubble-ston in foundation for east breakwater at Cleveland Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Monday, October 18, 1886, under advertisement dated September 25, 1886.]

No.	Name and address of bidder.	Rubble-stone, per cord.
1	Carkin, Stickney & Cram, East Saginaw, Mich	$5.90
2	L. P. & J. A. Smith, Cleveland, Ohio*	4.90
3	Robert Greenhulg and E. B. De Lamater, Cleveland, Ohio	5.45
4	Stang & Gillmore, Loraine, Ohio	5.24

* Lowest bid.

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Recommend that award be made to L. P. & J. A. Smith, of Cleveland, Ohio, at the rate of $4.90 per cord.

Abstract of proposals to furnish all the material, other than iron, and to do all the work of whatsoever kind necessary in the construction of 1,200 *linear feet, more or less, of east breakwater at Cleveland, Ohio.*

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at United States engineer office, Cleveland, Ohio, at 11 o'clock a. m., Monday, December 13, 1886, under advertisement dated November 12, 1886.]

Materials.	1. J. L. Johnson, Fulton, N. Y.		2. L. P. & J. A. Smith, Cleveland, Ohio.		3. Charles E. Williams, Buffalo, N. Y.*		4. F. H. Eggers, Cleveland, Ohio.	
	Rate.	Total.	Rate.	Total.	Rate.	Total.	Rate.	Total.
Hemlock, 1,384,000 feet, B. M.	$25.00	$34,600	$22.00	$30,448	$19.50	$26,988.00	$24.75	$34,254.00
White pine, 890,000 feet, B. M.	38.00	33,820	26.00	24,920	31.50	28,035.00	30.00	26,700.00
White oak, 97,600 feet, B. M.	50.00	4,880	30.00	2,928	33.94	3,312.54	40.00	3,904.00
Stone (foundation and filling), 7,600 cords	7.00	53,200	5.50	41,800	4.90	37,240.00	7.00	53,200.00
Stone, riprap, 12,000 tons	2.60	31,200	1.50	18,000	1.20	14,400.00	2.60	31,200.00
Treenails, 1,700 per 100	7.00	119	5.00	85	20.00	340.00	6.50	110.50
Total		157,819		118,181		110,315.54		149,368.50

*Lowest bid.

Recommend that award be made to Charles E. Williams, of Buffalo, N. Y., to furnish all the material, other than iron, required, and all the labor necessary to do the work, at prices in accordance with his proposal.

Abstract of proposals for furnishing all the iron required in the construction of 1,200 *linear feet, more or less, of east breakwater at Cleveland, Ohio.*

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at Cleveland, Ohio, at 11 o'clock a. m., Monday, December 13, 1886, under advertisement dated November 12, 1886.]

Materials.	1. A. Lacour, Cleveland, Ohio.		2. Charles W. Scofield, Cleveland, Ohio.*		3. William M. Pattison, Cleveland, Ohio.	
	Rate.	Total.	Rate.	Total.	Rate.	Total.
Iron plates, 13,500 pounds per pound	$0.03	$405.00	$0.03½	$472.50	$0.03½	$432.00
Iron angle plates, 3,375 pounds do	.03	101.25	.03½	118.12	.03½	108.00
S. and W. bolts, 19,000 pounds do	.03	570.00	.03½	617.50	.03	570.00
Drift-bolts, 188,000 pounds do	.02½	4,230.00	.02½	4,700.00	.02¾	4,512.00
Button-headed bolts, 11,000 pounds do	.06	660.00	.03	330.00	.03¾	374.00
Boat spike, 13,000 pounds do	.02¾	338.00	.02¾	357.50	.02 AA/100	318.50
Strap irons, 13,000 pounds do	.02½	325.00	.03	390.00	.02½	325.00
Bands, with hinge ends, 208 per unit	3.00	624.00	1.19	247.52	2.75	572.00
Bands, with hinge and angle ends, 104 do	3.00	312.00	1.64	170.56	3.25	338.00
Tie rods, 312 do	4.62	1,441.44	2.88	898.56	2.75	858.00
Turnbuckles, 156 do	1.20	187.20	1.13	176.28	1.10	171.60
Aggregate of bids		9,193.89		8,478.54		8,579.10

*Lowest bid.

Recommend award be made to Charles W. Scofield, of Cleveland, Ohio, for furnishing all the iron required, at prices in accordance with his proposal.

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Abstract of proposals for constructing 4,500 linear feet, more or less, of parapet wall on west breakwater at Cleveland, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Tuesday, May 10, 1887, under advertisement dated April 12, 1887.]

No.	Name and address of bidder.	Rate per M feet, B. M.		Rate per cord.	Rate per pound.			Removing and replacing 4,500 linear feet of decking, per 100 linear feet.	Total.
		White pine, 700,000 feet, B. M.	White oak, 14,600 feet, B. M.	Filling stone (945 cords).	Drift-bolts, (60,000 pounds).	Spike (6,200 pounds).	S. and W. bolts (2,200 pounds).		
					Cents.	Cents.	Cents.		
1	B. S. Horton, Vermillion, Ohio* ...	$30.50	$35.00	$6.00	3½	4	4½	$50.00	$32,228.00
2	Kerr, Stang & Gillmore, Lorain, Ohio† ...	30.00	32.00	5.50	3	3½	4	120.90	34,210.20
3	L. P. and J. A. Smith, Cleveland, Ohio‡ ...	30.00	30.00	5.00	2½	3	3	100.00	32,565.00
4	Courtland D. Merry, Burghill, Ohio ...	33.00	33.00	6.25	3½	3½	3½	50.00	34,132.05

* Lowest bid. † Highest bid. ‡ Next lowest bid.

Bid of B. S. Horton informal. The guaranty filled out on one proposal only, and that one does not comply with instructions as to certificate; also fails to comply with items 5, 6, 7, 8, 9, and 11 of instructions to bidders.

Recommend that, in view of the above informalities and the slight difference in total between the lowest and the next lowest bid, the work be awarded to Messrs. L. P. and J. A. Smith, of Cleveland, Ohio, at the prices named in their proposal.

ABSTRACT OF CONTRACTS FOR IMPROVING HARBOR AT CLEVELAND, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(1) Contract with L. P. and J. A. Smith, of Cleveland, Ohio, dated October 28, 1886, for furnishing and placing 3,600 cords, more or less, of rubble-stone for foundation for east breakwater. Rate paid, $4.90 per cord (of 128 cubic feet), delivered and placed. Contract extended, as to time of completion, to September 1, 1887.

(2) *Contract with Charles W. Scofield, of Cleveland, Ohio, dated January* 13, 1887, *for furnishing the iron required in the construction of* 1,218 *linear feet, more or less, of east breakwater.*

Material.	Rate.	Material.	Rate.
Iron plates ... per pound..	$0.03½	Strap-iron ... per pound..	$0.03
Iron angle plates ... do....	.03½	Bands with hinge ends ... each..	1.19
S. and W. bolts ... do....	.03½	Bands with hinge and angle end ... do....	1.64
Drift-bolts ... do....	.02½	Tie rods ... do....	2.88
Button-headed bolts ... do....	.03	Turn buckles ... do....	1.13
Boat spikes ... do....	.02½		

Contract extended, as to time of completion, to July 15, 1887.

(3) *Contract with L. P. and J. A. Smith, of Cleveland, Ohio, dated February* 28, 1887, *for furnishing all the materials, except iron, and doing all the work required in the construction of* 1,218 *linear feet, more or less, of east breakwater.*

Material.	Rate.	Material.	Rate.
Hemlock ... feet, B. M..	$22.00	Foundation and filling stone .. per cord..	$5.50
White pine ... do....	28 00	Riprap ... per ton..	1.50
White oak ... do....	30.00	Treenails ... per 100..	5.00

Work in progress. Time for completion of contract, June 1, 1888.

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(4) *Contract with B. S. Horton, of Vermillion, Ohio, dated May 27, 1887, for the construction of 4,000 linear feet, more or less, of parapet wall on west breakwater.*

Material.	Rate.	Material.	Rate.
White pine.....per M feet, B. M..	$30.50	Spike.....per pound..	$0.04
White oak.....do....	35.00	S. and W. bolts.....do....	.04½
Filling stone.....per cord..	6.00	Removing and replacing decking, per 100	
Drift-bolts.....per pound..	.03½	linear feet.....	50.00

Work in progress. Time for completion of contract, December 31, 1887.

ABSTRACT OF CONTRACTS FOR FURNISHING THE UNITED STATES ENGINEER OFFICE AT CLEVELAND, OHIO, WITH SUCH OFFICE SUPPLIES, STATIONERY, HARDWARE, ETC., AS MAY BE REQUIRED DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(5) Contract with Brooks & Co., of Cleveland, Ohio, dated November 11, 1886, for furnishing office supplies, stationery, etc. Total value of articles purchased under this contract, $192.21.

Contract completed and closed.

(6) Contract with McIntosh, Good & Huntington, of Cleveland, Ohio, dated November 2, 1886, for furnishing hardware, etc. Total value of articles purchased under this contract, $94.51.

Contract completed and closed.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO CLEVELAND HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. Army, dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887, was—	
For Cleveland Harbor proper.....	$368,400.00
For harbor of refuge.....	787,148.32
Estimated amount required to complete the improvement—	
The harbor of refuge.....	319,250.00
Approximate annual cost of preserving and maintaining—	
Cleveland Harbor proper.....	2,000.00
The harbor of refuge.....	10,000.00

The available depth for navigation in 1825, when the work of improvement was begun, was 4 feet. The commerce at that time is unknown, but was considerable.

The available depth for navigation is now 16 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

Amount of revenue collected.....	$299,330.60
The imports, consisting of general merchandise, iron ore, lumber, coal, provisions, and produce, amounting in value to.....	30,680,082.00
The exports, consisting of general merchandise, coal, iron, and oil, amounting in value to.....	46,501,153.00

Two thousand nine hundred and thirty-nine vessels, with an aggregate tonnage of 1,371,452 tons, entered; and 2,940 vessels, with an aggregate tonnage of 1,390,031 tons, cleared.

Of the vessels entering, the largest cargo was 2,504 tons of iron ore, and the deepest draught was 16 feet.

Of the vessels clearing, the largest cargo was 2,700 tons of coal, and the deepest draught was 15½ feet.

The work thus far executed has had a material effect in the reduction of rates of freight and insurance and of competing routes of transportation.

The completion of the proposed improvement would result in great benefit to the community, and is of daily and pressing importance to commerce. The commerce of this port is rapidly increasing beyond the capacity of the harbor to care for it.

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IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

Grand River rises in the northeastern part of Ohio, and, after a very circuitous course, empties into Lake Erie at a point about midway between its eastern and western extremities.

A full description of the operations carried on for the improvement of this harbor during the past fifty-five years will be found in Annual Reports for 1880 and 1881.

The project of improvement adopted in 1825, when the mouth of the river was closed by a sand-bar so hard and dry in summer that teams could drive across, and which project has been amended from time to time since that date as the demands of commerce called for an increased depth of water, provides for parallel piers, 200 feet apart, running out from each side of the entrance to a depth of 16 feet in the lake.

OPERATIONS DURING THE FISCAL YEAR.

There were no funds on hand at beginning of the fiscal year. There was only a 15-foot channel between piers and a 14½-foot channel through bars in lake at entrance to harbor. Dredging was badly needed, and the increased commerce of the harbor demands early relief.

As soon as possible after the passage of the river and harbor bill approved August 5, 1886, which appropriated $18,750 for this harbor, advertisement was made for proposals for doing the necessary dredging. The result was a contract, dated September 9, 1886, with William J. Starkweather, of Cleveland, Ohio, for dredging at 28 cents per cubic yard, place measurement. Work was commenced September 11, and continued, with numerous delays and interruptions, until October 30, when the contract was closed. About 4,930 cubic yards of material was removed from off the bar at entrance of channel and from channel between the piers. This resulted in giving a channel of fair but irregular width, and with least depth of 16 feet at low water. The sum of $1,380.40 was expended in the dredging.

A contract, dated October 9, 1886, was also entered into with L. P. and J. A. Smith for necessary repairs to the piers. Work was begun October 9 and finished November 6, 1886. The sum of $1,642.90 was expended. By this expenditure the piers were placed in fair repair to withstand the storms of winter and spring.

On March 8, 1887, proposals were invited for furnishing the materials and doing the work necessary for the extension of the east pier 200 linear feet. A contract was executed March 16, 1887, with Kerr, Stang & Gillmore, of Lorain, Ohio. Materials were delivered in April and operations commenced in May. At the close of the fiscal year the contractors were ready with the five cribs, of 40 feet by 24 feet each, for the proposed extension, and foundation for same was also about finished.

It is expected that by August 30 the whole work will be completed and the east pier thereby extended 200 feet, which will make the two piers extend to similar depth in the lake, and it is hoped will prevent the recurrence of the bar at entrance to piers.

The payments to be made under the contract with Kerr, Stang & Gillmore will exhaust the appropriation of August 5, 1886.

During the fiscal year the sum of $3,537.69 has been expended. Up to the close of the fiscal year the sum of $256,531.68 has been appropriated for this harbor, of which amount $241,319.37 has been expended.

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The present project provides for an extension of both piers, for repairs, and for dredging, so as to obtain and maintain a good channel 16 feet deep and 200 feet wide from the lake to railroad docks near mouth of river. The estimated cost is $93,000, of which sum $61,750 have been appropriated, and the balance, $31,250, can be expended during the fiscal year ending June 30, 1889.

Some trouble has been occasioned by the small bar forming this spring in lake beyond end of piers, but nothing could be done to remedy it for want of available funds, as all were pledged under existing contracts. Extensive improvements are being made at Fairport Harbor by Pittsburgh capitalists. These changes and improvements it is expected will be continued during the summer of 1887, and it is expected they will largely increase the amount of business of this harbor.

The extension of piers to the extent provided by the project should be made as soon as possible to prevent the recurrence of the bar formation, and some additional dredging will be necessitated by the extension of the docks.

An abstract of proposals and an abstract of contracts are transmitted herewith.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on shore and a beacon on the east pier.

The imports, consisting of iron ore, lumber, limestone, etc., amounted in value to $940,897. The exports, consisting of coal and railroad iron, amounted in value to $53,525 during the fiscal year ending June 30, 1887.

One hundred and thirty-six vessels, with an aggregate tonnage of 83,045 tons, entered, and 110 vessels, with an aggregate tonnage of 66,386 tons, cleared during the fiscal year ending June 30, 1887.

Of the vessels entering or clearing the largest cargo was 2,400 tons of iron ore, and the deepest draught was 15$\frac{4}{12}$ feet.

Money statement.

Amount appropriated by act approved August 5, 1886		$18,750.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,537.69	
July 1, 1887, outstanding liabilities	171.90	
		3,709.59
July 1, 1887, amount available		15,040.41
Amount (estimated) required for completion of existing project		31,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		31,250.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for dredging 10,000 *cubic yards, more or less, from channel of Fairport Harbor, Ohio.*

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Friday, September 3, 1886, under advertisement of August 18, 1886.]

No.	Name and address of bidder.	Price bid per cubic yard.		
		From channel inside.	From bar in lake.	For all the excavation.
		Cents.	*Cents.*	*Cents.*
1	L. P. & J. A. Smith, Cleveland, Ohio	*29	*29	*29
2	James Rooney, Toledo, Ohio			*31
3	William J. Starkweather, Cleveland, Ohio	†28	*28	†28
4	Stang & Gillmore, Lorain, Ohio	†30	†30	†30

*Scow measurement. †Scow or place measurement. ‡Lowest bid on basis of place measurement.

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Recommend that the award be made to William J. Starkweather, of Cleveland, Ohio, at the rate of 28 cents per cubic yard, place measurement, for all the excavation.

Abstract of proposals for furnishing the materials and doing the work for repairs, etc., at Fairport Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock, a. m., Monday, September 27, 1886, under advertisement dated August 20, 1886.]

Material.	L. P. & J. A. Smith, Cleveland, Ohio.*	Material.	L. P. & J. A. Smith, Cleveland, Ohio.*
White pine (23,445 feet, B. M.), per M feet, B. M	$32.00	Riprap ..... per cord..	$6.00
White oak (6,322 feet, B. M.), per M feet, B. M	40.00	Spike (2,000 pounds) ... per pound..	.04
Piles ..... per linear foot..	.35	S. and W. bolts ..... do....	.04
Brush ..... per cord..	3.00	Drift-bolts (600 pounds) ..... do....	.04
Filling stone (40 cords) ..... do....	7.00	Total	1,387.12

* Only bid received.

NOTE.—Bid considered reasonable where small amount of work to be done is considered, and advantageous for the Government to accept.

Recommend that the work be awarded Messrs. L. P. & J. A. Smith, at the prices named in their proposal.

Abstract of proposals for furnishing the materials and doing the work for extension of east pier and repair of piers at Fairport Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m., Tuesday March 8, 1887, under advertisement dated February 5, 1887.]

Material.	1. Courtland D. Merry, Burg Hill, Ohio.	2. Kerr, Stang & Gillmore, Lorain, Ohio.*	3. L. P. & J. A. Smith, Cleveland, Ohio.
Hemlock (195,828 feet, B. M.) ..... per M feet, B. M..	$21.90	$22.00	$21.00
White pine (106,644 feet, B. M.) ..... do....	32.00	31.00	31.00
White oak (5,950 feet, B. M.) ..... do....	35.00	30.00	32.00
Filling stone (850 cords) ..... per cord..	6.25	5.60	6.00
Riprap (100 cords) ..... do....	4.50	5.60	6.00
Drift-bolts (19,000 pounds) ..... per pound..	.03½	.02¾	.04
Spike (1,250 pounds) ..... do....	.03½	.04	.05
S. and W. bolts (3,000 pounds) ..... do....	.04½	.04	.05
Treenails (320 pounds) ..... per 100..	4.00	5.00	5.00
Dredging (1,200 cubic yards) ..... per cubic yard..	.40	.65	.60
Total	14,953.53	14,601.17	15,017.24

* Lowest bid.

Recommend that award be made to Messrs. Kerr, Stang & Gillmore, of Lorain, Ohio, at the prices named in their proposal.

ABSTRACT OF CONTRACTS FOR IMPROVING HARBOR AT FAIRPORT, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(1) Contract with William J. Starkweather, of Cleveland, Ohio, dated September 9, 1886, for dredging 10,000 cubic yards, more or less, of material from channel of Fairport Harbor, Ohio:

Rate paid, 28 cents per cubic yard, place measurement.

Contract completed and closed.

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(2) *Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 9, 1886, for repairs to piers.*

Material.	Rate.	Material.	Rate.
White pine.....per M feet, B. M..	$32.00	Riprap .....per cord..	$6.00
White oak.....do....	40.00	Spike.....per pound..	.04
Piles .....per linear foot..	.35	S. and W. bolts .....do....	.04
Brush.....per cord..	3.00	Drift bolts.....do....	.04
Filling stone .....do....	7.00		

Contract completed and closed.

(3) *Contract with Kerr, Stang & Gillmore, of Lorain, Ohio, dated March 16, 1887, for extension of east pier and repairs.*

Material.	Rate.	Material.	Rate.
Hemlock .....per M feet, B. M..	$22.00	Drift bolts.....per pound..	$0.02½
White pine.....do....	31.00	Spike.....do....	.04
White oak.....do....	30.00	S. and W. bolts .....do....	.04
Filling stone .....per cord..	5.60	Treenails .....per 100..	5.00
Riprap .....do....	5.60	Dredging .....per cubic yard..	.65

Work still in progress; time for completion of contract, August 31, 1887.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO FAIRPORT HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S A., dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887, $241,319.37.

Estimated amount required to complete the improvement, $31,250.

Approximate annual cost of preserving and maintaining, $2,000.

The available depth for navigation in 1827, when work of improvement was begun, was 6 inches.

No commerce at that time.

The available depth for navigation is now 16 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

The imports, consisting of iron ore, lumber, limestone, etc., amounted in value to $940,897.

The exports, consisting of coal and railroad iron, amounted in value to $53,525.

One hundred and thirty-six vessels, with an aggregate tonnage of 83,045 tons, entered; and one hundred and ten vessels, with an aggregate tonnage of 66,386 tons, cleared.

Of the vessels entering, the largest cargo was 2,400 tons of iron ore, and the deepest draught 15⅛ feet.

Of the vessels clearing, the largest cargo was 1,500 tons of coal, and the deepest draught was 15⅛ feet.

The work of improvement thus far executed has had a material effect in the reduction of rates of freight and insurance.

The completion of the proposed improvement would result in great benefit to the community, and is of daily and pressing importance to commerce, which is rapidly increasing beyond the capacity of the harbor to care for it.

L L 12.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

The original project for the improvement of this harbor was adopted in 1826, at which time there was a depth of only 2 feet of water on the bar; this project has been modified from time to time in order to meet the demands of commerce and increased draught of vessels navigating the lake. It provided for piers running out into the lake to 12 feet depth, whereas the present design is to carry them out to 16 feet depth.

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The piers at shore are 160 feet apart, but approach each other lakeward, and were only 100 feet apart, 900 feet offshore; then the west one flared to the westward in the next 200 feet, and at 1,100 feet offshore they were again 160 feet apart.

From this point outward the piers are parallel.

Before operations were commenced rock was encountered at 7 to 9 feet under the water-surface, extending across the channel in the form of a wide reef, which required blasting and dredging for its removal in order to secure the present depth of 15½ feet to 16 feet. The present project was continued during the fiscal year, under appropriation of August 5, 1886.

OPERATIONS FOR THE FISCAL YEAR.

At the beginning of the fiscal year there were no contracts in force nor any work in progress; funds were entirely exhausted. The act approved August 5, 1886, appropriated the sum of $30,000 for this harbor. A project was submitted for its expenditure, which was approved.

Proposals were invited as soon as practicable for dredging, which was badly needed at once to relieve the commerce of the harbor, and for repairs to piers and shore revetmental so greatly needed. A contract was executed, under date of September 11, 1886, with Messrs. L. P. & J. A. Smith, of Cleveland, Ohio, for the dredging at 29 cents per cubic yard, place measurement, for the dredging from bar in lake, and at 29 cents per cubic yard, scow measurement, for the dredging from between the piers. Operations were commenced September 16, 1886, and continued with some interruptions until November 30, when contract was closed. About 8,483 cubic yards were removed, of which 1,803 cubic yards were from bar and 6,680 cubic yards from channel between piers. The cost was $2,739.67. This dredging restored a fair 16-foot channel of irregular width.

A contract, dated October 9, 1886, was executed with L. P. & J. A. Smith, of Cleveland, Ohio, for repairs to piers. Work was commenced October 13, 1886, and finished December 28, 1886. The sum of $6,823 was expended. The piers were placed in fair repair, the balance of the old west pier removed to widen and straighten the channel, two sections of revetment of new bank of channel were placed on proper alignment, and the inner end of shore-line protected by mattress work.

In December, 1886, proposals were invited for the rock excavation, to the extent of the available funds. A contract, dated January 20, 1887, was executed with Messrs. Carkin, Stickney & Cram, of East Saginaw, Mich., for doing the required excavation at the rate of $2 per cubic yard for rock, and 90 cents per cubic yard for sand, gravel, etc. This work was not commenced until June, 1887, as the contractors determined to dredge the shale rock in place as well as the loose material. A powerful dredge was built especially for the work, and with it operations were begun June 6, 1887, and continued during the balance of the month. Good success was experienced in dredging the shale rock.

The contractors applied for and obtained an extension of time in which to do the work, and it is expected that they will remove all the material that the available funds (viz, $21,000) will pay for by the end of September, 1887.

The payments to be made under the contract with Messrs. Carkin, Stickney & Cram will exhaust the appropriation of August 5, 1886, by October 1, 1887.

Under the revised estimate the sum of $50,250 is required to complete

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the existing project; all of which amount can be profitably expended during the fiscal year ending June 30, 1889.

The piers should be extended as soon as possible to avoid the recurrence of the bar forming at end of pier. The rock excavation should also be completed as early as possible to make the full-width channel available. Dredging for the temporary relief of this harbor is almost annually needed, as the harbor is much frequented by the largest class of vessels. After these improvements are accomplished the renewal of the piers can be attended to.

The total amount appropriated for this harbor to the close of the fiscal year ending June 30, 1887, is $402,401.21, all of which will have been expended by October 1, 1887.

An abstract of proposals and an abstract of contracts are transmitted herewith:

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, varied by flashes, on the west pier. Fort Porter, New York, 120 miles distant, is the nearest work of defense.

For the fiscal year ending June 30, 1887, the imports, consisting of iron, ore, lumber, limestone, etc., amounted in value to $42,710.85. The exports, consisting of coal, coke, oil, etc., amounted to $940,516.

Six hundred and nineteen vessels, with an aggregate tonnage of 431,270 tons, entered, and 660 vessels with an aggregate tonnage of 453,012 tons, cleared, during the fiscal year ending June 30, 1887.

The largest cargo of vessels entering or clearing was 2,635 tons of coal, and the deepest draught was 16 3/12 feet.

Money statement.

Amount appropriated by act approved August 5, 1886		$30,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,727.36	
July 1, 1887, outstanding liabilities	3,215.06	
		10,942.42
July 1, 1887, amount available		19,057.58
Amount (estimated) required for completion of existing project		50,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		50,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for dredging 10,000 cubic yards, more or less, from channel of Ashtabula Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Friday, September 3, 1886, under advertisement dated August 18, 1886.]

No.	Name and address of bidder.	Price bid per cubic yard— From channel inside.	From bar in lake.	For all the excavation.
		Cents.	*Cents.*	*Cents.*
1	L. P. & J. A. Smith, Cleveland, Ohio	*29	†‡29	*29
2	James Rooney, Toledo, Ohio			*33
3	William J. Starkweather, Cleveland, Ohio	§35	§35	§35
4	Stang & Gillmore, Lorain, Ohio ‖	§30	§30	§30

* Scow measurement.
† Lowest bid for dredging from bar on basis of place measurement.
‡ Place measurement.
§ Scow or place measurement.
‖ Lowest bid for the inside work on basis of place measurement.

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Recommend that award be made to L. P. & J. A. Smith, of Cleveland, Ohio, at the rate of 29 cents per cubic yard, place measurement, for the dredging from bar, and at the rate of 29 cents per cubic yard, scow measurement, for the inside work.

Abstract of proposals for furnishing the materials and doing the work for repairs, etc., at Ashtabula Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Monday, September 27, 1886, under advertisement dated August 20, 1886.]

Materials.	1. A. F. McKenzie, Ashtabula, Ohio.	*2. L. P. & J. A. Smith, Cleveland, Ohio.
White pine (60,455 feet, B. M.) ....per M feet..	$37.00	$30.00
White oak (18,975 feet, B. M.)....do..	37.00	32.00
Piles....per linear foot..	.....	.35
To raise, repair, and sink two sections of revetment....	650.00	300 00
To remove 60 feet of old pier....	350.00	(†)
Brush (50 cords) ....per cord..	6.50	3.00
Filling stone (100 cords)....do....	7.00	6.00
Riprap stone ....do....	8.00	6.00
Spikes (2,064 pounds)....per pound..	.05	.04
S. and W. bolts (1,662 pounds)....do....	.05	.04
Drift-bolts (4,300 pounds)....do....	.04	.03
Total of bid	5,312.20	3,748.89

* Lowest bid for items bid upon. † No bid made.

NOTE.—No price given for removal of old pier, but taking price bid by the only bidder for this item, viz, $350, the bid of Messrs. L. P. & J. A. Smith would still be the lowest; and at prices bid in their letter, viz, $500, they are still the lowest.

Recommend that award be made to Messrs. L. P. & J. A. Smith at the prices named in their proposal. The price bid for removal of old pier in their letter is considered high.

Abstract of proposals for the excavation, removal, and deposit of 6,500 cubic yards, more or less, of ledge rock from channel between the piers and from bar in lake beyond end of piers, and 3,200 cubic yards, more or less, of loose rock, stones, gravel, sand, etc., from the channel at Ashtabula Harbor, Ohio.

[Received and opened by Maj. L. Cooper Overman, Corps of Engineers, at 11 o'clock a. m. Friday, December 3, 1886, under advertisement dated November 10, 1886.]

Class.	Material to be excavated.	Approximate number of cubic yards.	1. L. P. & J. A. Smith, Cleveland, Ohio.		2. Stang & Gillmore, Lorain, Ohio.		3. Carkins, Stickney & Cram, East Saginaw, Mich.	
			Rate.	*Amount.*	*Rate.*	*Amount.*	*Rate.*	*Amount*
A.	Solid rock from channel...	*4,500	$3.95	$17,775	$3.90	$17,550	$2.00	$9,000
A.	Solid rock from bar.....	*2,000	5.00	10,000	4.90	9,800	2.00	4,000
B.	Loose rock, all localities ..	†1,200	.35	420	2.00	2,400	2.00	2,400
C.	Stones and gravel, all localities.....	†1,000	.35	350	.60	600	2.00	2,000
D.	Sand and mud, all localities	†1,000	.35	350	.60	600	.90	900
	Total	.....	.....	28,895	.....	30,950	.....	18,300

* Place measurement. † Scow measurement.

Recommend that award be made to Messrs. Carkin, Stickney & Cram, at the rate of $2 per cubic yard, place measurement, for all the excavation of material of Class A; at the rate of $2 per cubic yard, scow measurement, for all the excavation of Class B and Class C; and at the rate of 90 cents per cubic yard, scow measurement, for all the excavation of material of Class D.

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ABSTRACT OF CONTRACTS FOR IMPROVING HARBOR AT ASHTABULA, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1887.

(1) Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated September 11, 1886, for dredging 10,000 cubic yards, more or less, of material from channel of Ashtabula Harbor, Ohio.

Rate paid for dredging from channel through bar in lake, 29 cents per cubic yard, place measurement; for dredging from channel inside, 29 cents per cubic yard, scow measurement.

Contract completed and closed.

(2) *Contract with L. P. & J. A. Smith, of Cleveland, Ohio, dated October 9, 1886, for repairs to piers.*

Material and work.	Rate.	Material and work.	Rate.
White pine.....per M feet, B. M..	$30.00	Brush.....per cord..	$3.00
White oak.....do ..	32.00	Filling stone.....do....	6.00
To raise, repair, and sink two sections of revetment.	300.00	Riprap.....do....	6.00
		Spike.....per pound..	.04
To remove 60 feet of old pier.....	500.00	S. and W. bolts.....do ..	.04
Piles.....per linear foot..	.35	Drift-bolts.....do....	.03

Contract completed and closed.

(3) Contract with Carkin, Stickney & Cram, of East Saginaw, Mich., dated January 20, 1887, for rock excavation and dredging.

Rate to be paid: For solid rock excavation, $2 per cubic yard, place measurement; for loose rock, stones, and gravel, $2 per cubic yard, scow measurement; for sand and mud, 90 cents per cubic yard, scow measurement.

Contract extended, as to time of completion, to September 30, 1887.

STATEMENT OF STATISTICS AND INFORMATION RELATING TO ASHTABULA HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. A., dated August 10, 1826, and April 4, 1887.]

Amount expended in the improvement to June 30, 1887.....	$380,128.57
Estimated amount required to complete the improvement.....	50,250.00
Approximate annual cost of preserving and maintaining.....	3,000.00

The available depth for navigation in 1826, when work of improvement was begun, was 3 feet.

The commerce of the port at that time is unknown.

The available depth for navigation is now 16 feet.

The commerce for the fiscal year ending June 30, 1887, was as follows:

The imports, consisting of iron ore, lumber, limestone, merchandise, etc., amounted in value to $42,710.85.

The exports, consisting of coal, coke, fruit, oil, etc., amounted in value to $940,516.

Six hundred and nineteen vessels, with an aggregate tonnage of 431,270 tons, entered; and 650 vessels, with an aggregate tonnage of 453,012 tons, cleared.

Of the vessels entering the largest cargo was 2,440 gross tons of iron ore, and the deepest draught was 16$\frac{1}{2}$ feet.

Of the vessels clearing the largest cargo was 2,635 tons of coal, and the deepest draught was 15$\frac{1}{2}$ feet.

The work of improvement thus far executed has had a material effect in the reduction of rates of freight and insurance.

The completion of the proposed improvement would be of great benefit to the community and is of daily and pressing importance to commerce, which is rapidly increasing beyond the capacity of the harbor to care for it.

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L L 13.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

No work has been done at this harbor during the last five fiscal years ending June 30, 1887. None is contemplated this season, as there are no funds available.

The project for the improvement of this harbor was adopted in 1829, and the bar at the mouth of Conneaut Creek was dry at low stages of water when the original improvements were commenced. Operations were carried on during the years of 1829 to 1832, and from 1836 to 1838, inclusive, which comprised the construction of piers 125 feet apart running out from shore to a depth of 12 feet of water in the lake, and dredging. The design was to afford a depth of 12 feet of water through the bar and into Conneaut Creek, the harbor of Conneaut.

Works of improvement have progressed with more or less interruptions and suspensions, no work having been done from 1832 to 1836, and from 1839 to 1844, from 1845 to 1852, from 1852 to 1866, none in 1885 and 1886, and none during the present fiscal year.

The best channel depth ever obtained at the entrance was only 11 feet, the more usual depth being from 8 to 9 feet, and the commerce of the port has always been trifling. We may, therefore, say the hopes entertained for this harbor, when its improvement was undertaken, have never been realized.

It has been recommended that improvements should be made at this harbor as follows:

Renewing 800 feet of old east pier at $30 per foot	$24,000
Rebuilding 790 feet of superstructure, west pier, at $10 per foot	7,900
Contingencies, 10 per cent	3,190
Total	35,090

I have nothing to add to this recommendation. Indeed, it seems to me that unless the facilities for transportation by land to and from this harbor should be materially augmented, any outlay for the improvement of the harbor is injudicious. Considerable sums have been expended during the last fifty years in preserving the harbor and its improvements without drawing private or incorporate enterprise in its direction; therefore the harbor must be regarded by citizens as of questionable advantage as a commercial outlet to and from the lake.

The total amount appropriated for this harbor up to the close of the present fiscal year was $112,629.39, all of which has been expended.

The estimated cost of completing the existing project is $35,090, which amount could be expended during the fiscal year ending June 30, 1889, for objects in accordance with the estimate quoted.

As the river and harbor bill, approved August 5, 1886, made no appropriation of funds for this harbor, no work was practicable, and the piers and revetment have still further deteriorated. The piers are in very bad condition, breaches having been make in both so that the stream now finds an outlet through the east pier, causing a bar near entrance of piers.

Unless some considerable expenditure is soon made for the repair of the piers they will be entirely destroyed.

Conneaut is in the collection district of Cuyahoga, Ohio. There was a fixed white light of the sixth order at the end of the west pier. Fort Porter, New York, 105 miles distant, is the nearest work of defense. The light has been moved up on to the bank on account of the dilapidated condition of the pier.

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The amount of revenue collected during the eleven months ending May 31, 1885, was $15.95.

The value of imports during the eleven months ending May 31, 1885, was $80, and of the exports $125.

Ten vessels, with an aggregate tonnage of 360 tons, entered, and twelve vessels, with an aggregate tonnage of 395 tons, cleared during eleven months ending May 31, 1885.

The deepest draught of the vessels entering or clearing was 6½ feet.

There have been no commercial reports for the fiscal years 1886-'87. The ex-deputy collector reports that the collector's office was abolished August 10, 1885.

Money statement.

Amount (estimated) required for completion of existing project	$35,090.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	35,090.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

STATEMENT OF STATISTICS AND INFORMATION RELATING TO CONNEAUT HARBOR, OHIO.

[Prepared in compliance with circular letters from the office of the Chief of Engineers, U. S. A., dated August 10, 1886, and April 4, 1887.]

Amount expended on the improvement to June 30, 1887	$112,629.39
Estimated amount required to complete the improvement	35,090.00
Approximate annual cost of preserving and maintaining	2,000.00

The available depth for navigation in 1829, when work of improvement was begun, was 2 feet.

No commerce at that time.

The available depth for navigation is now 7 feet.

The commerce for the eleven months ending May 31, 1885, is given in the following, no report having been received from this port of later date. The ex-deputy collector of customs writes that the office for collection of customs, etc., was abolished August 10, 1885.

Amount of revenue collected	$15.95
The value of the imports was	80.00
The value of the exports	125.00

Ten vessels, with an aggregate tonnage of 360 tons, entered, and twelve vessels, with an aggregate tonnage of 395 tons, cleared.

The deepest draught of any vessel entering or clearing the harbor was 6½ feet.

The work of improvement thus far executed has had no effect on rates of freight and insurance. There is no railroad reaching this harbor.

By the completion of the proposed improvement commerce would be benefited only to the extent of an improved channel of entrance, but it would not be liable to attract additional commerce to the harbor. The community would be indirectly benefited by the expenditure and by a better harbor.

L L 14.

PRELIMINARY EXAMINATION OF THE CHAGRIN RIVER (OHIO) AT ITS MOUTH.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, November —, 1886.

GENERAL: In compliance with circular letters from the office of the Chief of Engineers, dated Washington, D. C., September 27 and October 28, 1886, respectively, I have the honor to submit the following report of "preliminary examination" on the "examination or survey or both" of the Chagrin River at its mouth, as provided for in section 6 of the river and harbor act of August 5, 1886.

* * * * * * *

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It is assumed that the object of the survey or examination required is with a view to construction of a harbor at the mouth of the river, for the benefit of the adjacent country and possibly for a harbor of refuge.

From inquiry, from investigation of records, and from personal examination of the Chagrin River from Willoughby, Ohio, to its mouth, I respectfully submit the following:

The Chagrin River rises in Geauga County, Ohio, and, flowing north for a distance of about 30 miles, empties into Lake Erie about 2½ miles north of the town of Willoughby, Ohio, about 10 miles west of the harbor at Fairport, Ohio (mouth of Grand River), and about 20 miles east of the harbor of Cleveland, Ohio. Between Willoughby and the lake the stream is very shallow until a point about 1 mile from the lake is reached, where it presents a width of 110 feet and a depth of 7 feet. Here it divides into two nearly equal branches, and the channel naturally shoals immediately in both. The east branch is the principal, and the west has heretofore been cut off by a pile dike, which is now in a dilapidated condition. At this dike the depth in both channels is from 1 to 4 feet, and it very gradually increases to 10 feet as we descend the stream, with an occasional pool presenting a greater depth until a point is reached about 400 feet from the lake beach. Here both branches unite and form a pool with a maximum depth of 18 feet. This is, however, almost entirely cut off from the lake, the sand beach having formed with a width of from 25 to 100 feet, and the river discharging through a constantly shifting opening, at present about 30 feet wide, with a depth of from 1 to 2 feet.

At present there is no commerce, and there is no harbor of any sort. It is possible that if a harbor were constructed that commerce might follow; but, with the large city of Cleveland only 20 miles to the west, Fairport with its lines of railroad only 10 miles to the east, and the Lake Shore Railroad connecting all these, it is doubtful if any considerable amount of commerce would ever be attracted to the mouth of the Chagrin River even if it were made accessible to lake commerce.

Attention is invited, in connection with this report, to report of Maj. John M. Wilson, Corps of Engineers, dated September 24, 1880, upon a survey of Chagrin River, Ohio, made in compliance with act of Congress approved June 14, 1880, some portions of which I have quoted herein. In that report the approximate cost for a harbor at mouth of Chagrin River is estimated at $200,420, an expenditure entirely disproportioned with the probable commerce of the country adjacent to the mouth of Chagrin River. Situated as it is, so near to the harbors of Cleveland and Fairport, where vessels drawing 16 feet of water can enter at all times, and with a harbor of refuge three-fourths completed at Cleveland, Ohio, I am of the opinion that the mouth of Chagrin River is not worthy of improvement and that the demands of commerce, either present or prospective, do not call for the construction of a harbor at the locality mentioned.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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L L 15.

PRELIMINARY EXAMINATION OF SANDUSKY HARBOR, OHIO, WITH A VIEW TO A STRAIGHT CHANNEL FROM THE NORTH END OF CEDAR POINT TO THE EAST END OF THE EXISTING CHANNEL IN FRONT OF THE CITY.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, November 8, 1886.

GENERAL: In compliance with circular letters from the office of the Chief of Engineers, dated Washington, D. C., September 27, and October 28, 1886, respectively, I have the honor to submit the following report of "preliminary examination" for survey in "Sandusky Harbor with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city" of Sandusky, Ohio, as provided for in section 6 of the river and harbor act of August 5, 1886.

* * * * * * *

In compliance with instructions in letters above mentioned, I made a personal examination of the line indicated; I also communicated with a number of parties in Sandusky, Ohio, who were interested in the commerce of that city and who had been instrumental in having the survey ordered by Congress. They gave me full information as to the object of the survey and showed me a copy of a report with maps, plans, and estimates which they had submitted to the Committee on Rivers and Harbors of the House of Representatives when advocating the survey.

They also had prepared at my request a statement showing in part the commerce of Sandusky during the past five years.

* * * * * * *

From the preliminary examinations made and from information gained I am inclined to concur in the views of those who advocate a straight channel, and am, therefore, of the opinion that the proposed straight channel is worthy of improvement from facts and reasons given above, and that it is called for from the present and prospective demands of commerce as shown by statistics.

The rapid growth of the commerce of Sandusky is clearly shown in the report submitted by the collector of customs, Mr. Finch, a copy of which is inclosed herewith. From this report it will be seen that in five years the imports of ore at this harbor increased from 49,000 tons to 144,000 tons, and the shipments of coal have increased from 69,800 tons to 117,700 tons, and that shipments of grain are also increasing rapidly.

Sandusky City Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range lights within the bay. Fort Wayne, below Detroit, is the nearest work of defense.

The amount of revenue collected during eleven months ending May 31, 1886, was $6,400.30.

The value of foreign imports was $40,693.83, and of the foreign exports $47,957.

The imports consisted of fresh and salt fish, wood, cattle, furs, and sundry items.

The exports consisted of coal, lumber, rope, and twine.

Eleven hundred and sixty-nine vessels, with an aggregate tonnage of 218,130 tons, entered, and 1,180 vessels, with an aggregate tonnage of 229,553 tons, cleared during eleven months ending May 31, 1886.

The largest cargo that entered was 1,954 tons of iron ore; the largest cargo that cleared was 2,150 tons of coal.

The deepest draught of vessels entering or clearing was 15 feet 4 inches.

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The collector of customs, in submitting his report, writes:

The character of business to and from this port is constantly changing from small to large vessels, which fact is clearly illustrated by a comparison of the receipts of iron ore for the past three years, as follows: Iron ore received in 1883, 58,825 tons; in 1884, 106,540 tons; and in 1885, 143,180 tons. These figures place Sandusky third in rank, so far as ore receipts are concerned, of all Lake Erie ports. The shipments of coal for eleven months ending May 31, 1885, were 31,874 tons, and the shipments of coal for eleven months ending May 31, 1886, were 109,662 tons. With a deep, straight channel from lake to channel in front of the city docks the business of the port would largely increase and the vessel interest be greatly benefited.

At present the largest vessel running from Sandusky has a capacity of 2,150 tons, and when so loaded will draw 15½ feet of water.

The prospects for the rapid increase of the commerce of Sandusky are most flattering, and the advantages of a "straight channel" with depth of 16 to 17 feet at low water can hardly be estimated.

In further compliance with terms of circular letter from the Chief of Engineers, dated October 28, 1886, I have respectfully to submit an estimate of $550 as the cost of the survey.

* * * * * * *

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

SURVEY OF SANDUSKY HARBOR, OHIO, WITH A VIEW TO A STRAIGHT CHANNEL FROM THE NORTH END OF CEDAR POINT TO THE EAST END OF THE EXISTING CHANNEL IN FRONT OF THE CITY.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, February 2, 1887.

GENERAL: I have the honor to transmit herewith, in separate package, a chart* (tracing) of a portion of Sandusky Bay, Ohio, together with profiles† (tracing) along line of proposed new channel, and to submit the following report of a survey made in accordance with act of Congress approved August 5, 1886:

The port of Sandusky, Ohio, is situated on Sandusky Bay, which bay empties into Lake Erie about 40 miles from the western end of the lake. Sandusky Bay is a natural harbor, containing an area of about 22½ miles, with a depth of from 8 to 12 feet. It is protected on the north and northwest by a narrow peninsula, and on the east by another point of land known as Cedar Point. Sandusky River is the only stream of any size which empties into the bay, which it does at its southwest extremity, some 14½ miles from Cedar Point.

The channel by which vessels reach Sandusky City docks is the result of plan for improvement adopted in 1864, which plan has been amended from time to time, until now it provides for dredging and maintaining a channel through the bar outside of Cedar Point and through the bay to within 50 feet of the line of the city docks, and then parallel to the line of docks. The channel through the bar and bay to be 200 feet wide, while that parallel to the docks is 100 feet wide; and all to have a depth of 15 feet.

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*Omitted. Printed in Senate Ex. Doc. No. 78, Forty-ninth Congress, second session.

†Not printed.

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By this channel it is nearly 4½ miles from deep water of the lake to city docks.

This route was selected for improvement in 1864, when the commerce of Sandusky was small as compared with its present commerce, whilst the commerce of Sandusky River was sufficiently large at that time to influence the route selected for improvement, and when lake vessels did not require over 13 feet channel depth.

It was the route at that date which could be improved for the least expenditure of funds and promised the earliest relief to the commerce which entered the bay. For some years past, however, much objection has been made to the existing channel. It is crooked and difficult for vessels to navigate, and requires three sets of range-beacons to enable a vessel to follow it. The want of sufficient depth is also complained of. In 1882 an increase of channel depth to 16 feet was recommended by the engineer in charge, and an estimate of $61,000 submitted for the additional dredging required; but since this latter date the commerce of Sandusky has increased so rapidly, and the increased and increasing draught of lake vessels make 17 feet depth of channel necessary. This additional depth will cost at least $50,000 more, making a total of $111,000 necessary to make the existing channel of adequate depth for present demands of commerce.

As the commerce of Sandusky City grew in importance, the question as to the best line for the portion of the channel through Sandusky Bay (*i. e.*, inside of Cedar Point) was discussed, and especially so of late years. As far back as 1873 the *straightening* of the route by cutting a new channel through "Horse Shoe Shoal," or the middle-ground, was reported upon by the then engineer in charge.

This question has not ceased to be agitated by the citizens of Sandusky, and, with the knowledge that additional appropriation would be necessary for the increased depth required, they had an examination made at their own expense in the fall of 1884 to determine the approximate cost of straightening the present channel by cutting through the "middle-ground," thereby making a direct route from the city docks to Cedar Point.

The examination developed the fact that a very favorable line existed for such a direct route and with comparatively little cutting to make 17 feet depth. A committee of the citizens of Sandusky presented the matter to Congress during the session of 1885, but the failure to pass a river and harbor bill that year prevented any definite action being taken.

The effort was renewed in 1886, and resulted in a survey being authorized by act of Congress approved August 5, 1886. The act provides for an examination or survey and the cost of improvement to be estimated at "Sandusky Harbor with a view to a straight channel from the north end of Cedar Point to the east end of the existing channel in front of the city."

In compliance with instructions from the Office of the Chief of Engineers, United States Army, dated September 27 and October 28, 1886, I made a preliminary examination of the proposed line, and under date of November 8, 1886, I submitted a report of said personal examination, with estimate of cost of a survey, in which report I recommended "the project worthy of improvement, and that it was called for by the present and prospective demands of the commerce of Sandusky."

The report was approved and the survey ordered to be made. A field party under charge of B. H. Colby, assistant engineer, made the survey from the surface of the ice which then covered the bay. The work was

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done with accuracy and dispatch, and Mr. Colby displayed commendable energy and push in the work under his charge.

The route for the proposed straight channel being so definitely designated in the act authorizing the survey, it was only necessary to locate the line to make the required soundings, and to make an examination of the character of the bottom through which the cutting would have to be made, to enable the "estimate of cost of improvement" to be determined. The line was found to be 9,465 feet in length, and joins the existing channel outside of Cedar Point by an easy curve and unites with the channel in front of city docks by an easy curve. The survey demonstrated a very favorable line, with comparatively small amount of cutting to make a channel with 17 feet depth.

About 25,000 soundings were taken and 75 borings were made. The maximum cut to gain 17 feet was 12.4 feet, the minimum cut 4.4 feet, the average cut being 7.1 feet.

The borings to determine the character of the materials were made to 18 feet below the surface of the water, and indicated that (beginning at the east end of the channel parallel to the city docks) for the first 3,500 feet of the route the material was mud overlying a *clay* bottom—the clay appearing at about 16 feet below surface of water—beyond this no clay was found at a depth of 18 feet or less; for the next 1,000 feet mud only was found; then a mixture of mud and sand for the next 2,000 feet. At 6,450 feet from the beginning point a bed of quicksand was struck at a depth of 17 feet, with coarse sand overlying it and mud beneath. The bed varied in thickness from 1 foot to 6½ feet, extending the remainder of the route, and for full *width* for which borings were carried, viz, 260 feet. The mud was found under it in all places at from 16 to 17 feet below water-surface. The bed of quicksand gave indications of ending at the deep hole near Cedar Point, in which a depth of from 18 to 30 feet exists.

The material along the entire line is, therefore, favorable for easy dredging.

An examination of the tracings submitted with this repart shows the great advantage, both in *directness* and *length*, of the proposed new route, the saving in distance from the city docks to Cedar Point being 6,076 feet in 15,540 feet, or nearly 40 per cent.

As the proposed route is a direct channel, all the disadvantages to navigation resulting from "turns" and "bends" will be obviated, and being a straight channel, the liability to fill in during the winter and spring will be very much less. The *annual* amount of dredging for maintenance will therefore be much less, and the line a shorter one to maintain. Being well protected on the east side by Cedar Point, the unprotected cut will not be so liable to damage from storm, especially from northeast gales. The new route from Cedar Point into the city docks will require but one set of range marks for vessels to navigate it, and one of these it will have already prepared in the city clock-tower, a well-defined, permanent, and visible beacon by day or night, in direct range of the proposed channel.

With regard to "liability to fill?" The new route has equal if not superior advantages over the existing one.

There are two well-defined currents in Sandusky Bay, produced in part from the outflow from Sandusky River. One sweeps along in front of the city docks and enters the lake by the eastern channel (east of "*the middle ground*"). The other passes the south of Johnson's Island and enters the lake by the west channel. Between these two channels lies the "Horse Shoe Shoal" or middle ground.

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As the proposed new channel follows very nearly the route of the eastern *current*, it is expected that said current will aid materially in maintaining the depth of channel along the new route after it has once been obtained.

Therefore, while I believe that *any* unprotected channel through Sandusky Bay will gradually fill up without annual dredging, it is thought that the proposed straight channel will be as little liable so to do as any other, for reasons already stated.

Hence the question of *protecting* the channel, which may ultimately have to be done, does not enter into this discussion, since it is a detrimental factor in the existing route and in all routes, but when considering this factor the shortest route must have the advantage.

Further, the protection of the cut should not be decided until actual results shall determine the annual cost to maintain the unprotected cut by dredging and what kind and how much is needed, as it is thought that a percentage as low as 3 per cent. on the cost of any method of protection will pay for the annual cost of dredging.

To make a channel 200 feet wide at bottom and 17 feet deep at low water along the route designated, which dimensions for the channel are the least that will accommodate the commerce of Sandusky, the following estimate is submitted.

Excavation, removal, and deposit of 538,000 cubic yards of material, measured in place (of which 6 per cent. approximately is clay, 56 per cent. approximately mud or mud and sand mixed, 22 per cent. approximately sand, 15 per cent. approximately quicksand), or say 628,000 cubic yards, scow measurement, at 14 cents per cubic yard	$87,920
Contingent expenses, say 10 per cent	8,792
Total	96,712

The rate (of 14 cents) is deemed adequate, since the dredges when at work for nearly the entire length of the line, will be protected from severe northeasterly gales by Cedar Point; the material to be removed is favorable for dredge work, and the average face of the cut a good one for such work. Further, the rate for dredging in Sandusky Bay of late years for much less favorable work, more exposed and in small amounts, has been only 15 cents.

As the proposed straight channel has many advantages over the existing route, the only remaining objection to making a change will be the question of expense. To complete the project for existing channel it is estimated that $10,000 will be required for the part from Cedar Point to city docks; and to give 17 feet depth to said part of the channel will require at least $40,000 of the $111,000 heretofore shown as necessary for the entire length of the channel.

We have therefore an estimate of $50,000 required to secure 17 feet depth and otherwise complete the existing channel from city docks to Cedar Point in accordance with plans recommended, admitting the necessity of the work.

The cost to make the new channel from city docks to Cedar Point will be, then, the difference between $50,000 and $96,712, viz, $46,712; a small amount when the advantages of the proposed new route are considered.

If the work along the proposed new route be undertaken and a channel 200 feet wide at bottom and 17 feet deep at low water be provided for, the same could be readily done in one season, if the whole amount estimated as necessary, viz, $96,712, be appropriated in one allotment, which would enable the work to be contracted for on favorable terms,

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and further work on the existing channel, inside of Cedar Point, could be dispensed with. Further, I am of the opinion that after said new channel is completed it can be maintained by dredging at an annual cost of, say, $5,000.

The following interesting statistics in regard to the commerce of Sandusky are submitted. They were kindly furnished me by Mr. John J. Finch, collector of customs, Sandusky, Ohio:

Amount of revenue collected during the calendar year 1886, $4,629.10.

Value of imports, consisting chiefly of fish, round timber, and wood, $40,231.65.

Value of exports, consisting chiefly of coal, grain, rope, and breadstuffs, $222,058.

Nine hundred and eighty-four vessels, with an aggregate tonnage of 237,461 tons, entered, and 990 vessels, with an aggregate tonnage of 242,112 tons, cleared, during the calendar year 1886.

The deepest draught of vessels entering or clearing was 15 feet 8 inches.

The largest cargo entering the port was 2,589 gross tons (iron ore), carried by the steamer *Onoko*, draught 14 feet 10 inches.

Among the vessels entering the port during the calendar year 1886 were the following:

Steamer *Nebraska*, cargo 1,500 tons flour, draught 14 feet 10 inches; schooner *John Shaw*, cargo 1,738 tons iron ore, draught 15 feet 8 inches; steamer *Magnetic*, cargo 2,086 tons iron ore, draught 14 feet 10 inches; steamer *Specular*, cargo 2,100 tons iron ore, draught 14 feet 10 inches; steamer *Onoko*, cargo 2,589 tons iron ore, draught 14 feet 10 inches; steamer *Ohio*, cargo 1,210 tons iron ore, draught 15 feet 3 inches; steamer *James Pickards*, cargo 1,708 tons iron ore, draught 14 feet 10 inches; schooner *Couch*, cargo 1,516 tons iron ore, draught 15 feet 4 inches; schooner *Susan Peck*, cargo 1,872 tons iron ore, draught 14 feet 10 inches; steamer *Chisholm*, cargo 1,934 tons iron ore, draught 15 feet; steamer *Nebraska*, cargo 1,000 tons copper and 500 tons pig-iron.

Among the vessels clearing were the following:

Schooner *John Shaw*, cargo 1,856 tons coal, draught 15 feet 8 inches; schooner *H. A. Kent*, cargo 1,600 tons coal, draught 15 feet 6 inches; steamer *Ohio*, cargo 1,200 tons coal, draught 15 feet 3 inches.

The foregoing is a partial statement of the business of the port with ports outside of this district; is partial only for the reason that many large and heavily-laden vessels clear for ports beyond this port, enter here, discharge and receive freight without making any report to the custom-house whatever. Notably among such are the "Anchor Line" steamers, which clear from Buffalo, N. Y., through to Chicago, Ill.; one of said steamers coming usually into this port two or three times a week throughout the season.

I also append hereto an incomplete statement, but comprising the greater part of the business of this port with the ports within this district; the same being largely with the islands in the district, and consequently not reported to the custom-house, which is compiled from written statements furnished at my request by the owners and managers of the vessels engaged principally in such traffic, and is as follows:

Number of vessels entered from ports or places within the district, 1,514; tonnage of same, 158,977 tons.

Number of vessels cleared for ports or places within the district, 1,506; tonnage of same, 158,401 tons.

Number of tons of freight carried by the above-mentioned vessels during the year 1886, 106,399 tons.

Number of passengers carried by such only of the foregoing vessels as are principally engaged in the carriage of passengers, 89,727.

The following statistics show the increase of receipts and shipments by *lake* at the port of Sandusky, Ohio, of the two principal railroads terminating at said port, viz, the Baltimore and Ohio, and the Indianapolis, Bloomington and Western railroads, obtained from official sources.

RECEIPTS OF ORE BY THE BALTIMORE AND OHIO RAILROAD.

	Tons.
1882	49,123
1883	58,820
1884	107,704
1885	143,180
1886 (to October 18)	144,096

Receipts of flour in 1886, in transit, from Duluth to Belfast, Ireland, and London, England, via the Baltimore and Ohio Railroad and Baltimore, 29,000 barrels.

The Baltimore and Ohio Railroad also received in 1886, in transit, from Duluth to Europe, via Baltimore, to October 1, over 1,000,000 bushels grain.

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SHIPMENTS OF COAL BY THE BALTIMORE AND OHIO RAILROAD.

	Tons.
1882	69,846
1883	100,895
1884 (year of strikes)	31,874
1885	96,637
1886 (to October 18)	117,742

The Baltimore and Ohio Railroad shipped by "Anchor Line" steamers, etc., in 1886, to October 1, over 5,000 tons merchandise.

The Indiana, Bloomington and Western Railway shipped in 1886, by lake, to New York and Eastern ports, to October 1, 1,750,000 bushels grain.

The grain shipments at this port by lake have for a number of years prior to 1886 been so light as to be scarcely worth mentioning.

Receipts of grain by the Baltimore and Ohio Railroad have been increasing ever since the new elevator was built.

As you are probably aware, the traffic above given has been mostly carried on in vessels of the large size.

It is hardly necessary to comment on the above, as the foregoing statistics plainly show the rapid increase, of late years, in the commerce of Sandusky, and give abundant evidence as to the prospective increase; and I earnestly recommend that a wide, straight, and easily-navigated channel, with full depth of 17 feet, may be authorized at an early day. The whole amount of the funds estimated for the improvement could be profitably expended during the fiscal year ending June 30, 1888.

Sandusky City Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point, with a fixed white light of the fifth order, and three range-lights within the bay.

Fort Wayne, below Detroit, is the nearest work of defense.

Very respectfully, your obedient servant,

L. COOPER OVERMAN,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX M M.

IMPROVEMENT OF THE HARBORS OF ERIE, PENNSYLVANIA, AND DUNKIRK, BUFFALO, WILSON, OLCOTT, AND OAK ORCHARD, NEW YORK, AND OF NIAGARA RIVER, NEW YORK.

REPORT OF CAPTAIN FREDERICK A. MAHAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Dunkirk Harbor, New York.
3. Buffalo Harbor, New York.
4. Niagara River, New York.
5. Wilson Harbor, New York.
6. Olcott Harbor, New York.
7. Oak Orchard Harbor, New York.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., August 1, 1887.

SIR: I have the honor to forward herewith my annual reports of works of river and harbor improvement under my charge for the year ending June 30, 1887.

Very respectfully, your obedient servant,

F. A. MAHAN,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

M M 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

I relieved Capt. C. F. Palfrey, Corps of Engineers, of the charge of this work on September 30, 1886, in compliance with paragraph 15, Special Orders No. 188, dated Headquarters of the Army, Adjutant-General's Office, Washington, Agust 14, 1886.

PROTECTION OF THE WEST NECK OF THE PENINSULA.

All the protection fences and pile-jetties are so broken down, and have become so rotten that they may be said to have no existence. The narrowest parts of the neck are of such height and width that the water does not come over them except in unusually severe storms, such as that of October 14, 1886, when the waves did roll across from the lake to the bay. No harm was done beyond the rooting up of a few willows planted some years before.

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THE CHANNEL-PIERS AND BREAKWATER.

The north pier is in good condition. The south pier needs some slight repairs. During the early summer of 1886 a small breach about 50 feet long was made in the south breakwater. This was lengthened to 100 feet by a severe gale on October 14, 1886. This breach will be closed and some minor repairs will be made this year.

THE CHANNEL.

When I took charge of this harbor Captain Palfrey had already prepared a project for dredging between the piers and through the bar in front of them. This project was approved by the Chief of Engineers, and bids for doing the work were invited by circular letter.

On September 30, 1886, the bids were opened for this work. It was awarded to James Rooney, of Toledo, Ohio, at 26 cents per cubic yard, and a contract was made with him on September 30, 1886.

The work was so hindered by the storms and gales of the autumn that it was impossible for the contractor to complete his work by the time required, January 1, 1887. An extension was granted until July 1, 1887. The work was finished on June 25.

The present project for the improvement of this harbor contemplates the extension of the piers to the 16-foot curve in the lake and the maintenance of a channel not less than 16 feet deep through the bars inside and outside of the piers. Maj. M. B. Adams, Corps of Engineers, in his annual report for 1883, says:

> The amount required to complete the existing project, *i. e.*, to extend the piers to 16 feet depth of water in the lake, cannot well be definitely stated, owing to the continuous accumulation of sand on the outer bar, which makes it highly probable that considerable extensions, some 1,000 feet to the north pier and 1,650 feet to the south pier, will be required to reach the 16-foot curve in the lake by the close of another season. * * * Unless * * * the sand should be prevented from accumulating as it now does, either large amounts of sand will require removal or else indefinite extensions to the piers must be made in order to maintain a depth of 16 feet through the outer bar. There are required at present 2,050 feet of pier extension, 700 feet to the north pier and 1,350 feet to the south pier, in order to reach the place where the 16-foot curve crosses the channel, which, at a cost of $65 per foot, will amount to $133,250, the sum required to complete the existing project at the present time.

Captain Maguire, in his annual report for 1885, after referring to the above extract from Major Adams's report of 1883, says:

> I have nothing to add to the above except in the way of indorsement of the statements made, but in my opinion there should be no further extension of the north pier. During storms the water rushes through the channel between the piers like a mill-race, and again upon a cessation of the storm when the lake begins to resume its level. The longer the channel is made, under these circumstances, the more difficult it will become for vessels to enter the harbor. In my opinion the movement of the sand from and along the peninsula may be arrested in the manner proposed in my report of January 7, 1885. In view of the fact that the channel has already shoaled in front of the piers, I am of the opinion that the south pier may be profitably extended 400 feet. The estimate for the breakwater protection for the neck (of the peninsula) and the jetties, as submitted in the report above referred to, is $147,044.50.

I agree entirely with Captain Maguire except as to the advisability of prolonging the south pier, unless it be found that the system which I am about to propose should not give the results which I expect from it.

At the time the engineer office at Buffalo was burned out I had just finished and was correcting the translation of a very interesting paper by MM. Plocq and Guillain, of the Ponts et Chaussées, on the dredging at the harbors of Dunkirk, Calais, and Boulogne, on the north coast of France.

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The harbor of Dunkirk, France, like the harbor of Erie, has experienced great difficulty in keeping open the entrance to the piers on account of the enormous amounts of material which are constantly swept along the north shore of France. The prevailing wind there is from the west. The current caused by the incoming tide from the Atlantic through the Strait of Dover is very powerful. The north shore of France and the bed of the strait is mainly composed of sand. The conformation of the shores of France and England form a sort of nozzle. Under the influence of the tides and the westerly winds the sand is swept eastwardly and deposited in large quantities along the shore near Dunkirk and on the banks which lie in front of the harbor.

Various means have been tried to keep the entrance to the harbor clear; scouring-basins, with their strong currents; dredging between and in front of the piers, etc. None of these methods was satisfactory. Finally the experiment was tried of digging on the west side of the west pier a large pocket into which the sand traveling along the shore could be deposited. This system is giving very satisfactory results.

I think that the experiment might well be tried at Erie so soon as the channel which has just been dredged in front of the piers begins to fill up. A pocket might be excavated on the north side of the north pier of sufficient size to receive the material which drifts down to the mouth of the piers. I am greatly of the opinion that the entrance can be thus kept clear. An incidental advantage of this system will be that no obstruction to navigation will be caused while doing the work.

The use of ordinary bucket and ladder dredges had to be abandoned on the north coast of France on account of the difficulty of working them when there was any sea. I find that with a swell of 18 inches dredging with the ordinary machine used on Lake Erie becomes well-nigh impracticable.

The engineers in charge of harbor improvements on the north shore of France, and particularly those at Dunkirk, had for some time been desirous of using suction-dredges, believing them to be best adapted to the purpose. The French contractors, who were receiving about 60 cents per cubic meter, would not adopt these dredges. The engineers then had two or three of them brought from Holland, their owners having offered to do the work for less than 40 cents. Being forced to do so, the French contractors then built some suction-dredges, and the price of dredging was soon brought down by competition to about 13 cents per cubic meter, including the transportation of the dredged material to distances into the open sea varying from 1 mile at Bologne to 3 miles at Dunkirk.

The suction dredges were of two types according to the location of the suction-pipes. In the first the pipes were in a well situated in the median plane of the vessel. In the second type the suction-pipe was outside of the hull. In both it inclined down toward the bow. The first type was further divided into two classes according to the position of the centrifugal pump. In the first class the axis of rotation of the pump was but little above the surface of the water when the vessel was light. In the second the whole pump was above the surface. In the first class access to the pump was difficult, but no priming was necessary. In the second class access was easy, but the pump had to be primed. In the second class the priming pump was sometimes used for the purpose of sending a strong current down to the lower end of the section-pipe in order to stir up the material and loosen it to such an extent as to be easily drawn in with the water.

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The most approved type was the first, *i. e.*, the one having the suction-pipe in the middle of the vessel.

The dredge itself is an ordinary propeller containing a number of bins to receive the material dredged. The main engine is so arranged by means of suitable gearing that it can be used to drive the propeller wheel or the pump.

The suction-pipe is raised or lowered by means of rigging near the bow. The well of the suction-pipe is separated by a partition at its after end from the pump-chamber.

These dredges work successfully when the swell is as great as 4 or 5 feet.

When work is to be begun the vessel steams into position on the range assigned. It first passes some distance ahead of where the cut is to begin and drops an anchor to which a cable is attached. The vessel then backs to the beginning of the cut. The suction-pipe is lowered and the pump, having been geared to the main engine, is started. When the pumping begins the free end of the suction-pipe is raised and lowered alternately until it settles itself well down in the material to be moved.

The pump is from 6 to 8½ feet in diameter. The suction is so powerful that the vessel is constantly drawn ahead against the face of the cut. The head line has rarely to be used, but it is always kept in place in case of emergency.

So soon as the bins are filled the vessel buoys her anchor and goes to the dumping-ground. After dropping her load she returns to work.

The time of taking up a load, going out with it, dropping it, and returning to place, varies at the three harbors, being shortest at Boulogne, and longest at Dunkirk. At the former point the material to be removed is most favorable, being wholly sand, and the length of haul being least.

The most effective work is done in sand, the least in mud. With the latter material a large proportion runs overboard with the water which passes out of the bins.

During the coming year it is proposed to repair the piers and breakwater, and to make a careful survey of the peninsula, all maps in this office having been destroyed by fire on March 15, 1887.

During last winter, while dredging operations were suspended, I had the inspector collect all the information he could on the subject of the commerce of the city of Erie. These statistics have been received, but owing to more pressing work I have been unable to put them into proper shape to submit with this report.

The following contracts were made during the year:

On September 30, 1886, with James Rooney for dredging.

On June 17, 1887, with Daniel McNaughton for iron.

On June 23, 1887, with G. Elias & Bro. for timber.

Money statement.

July 1, 1886, amount available		$58,029.23
Amount appropriated by act approved August 5, 1886		37,500.00
		95,529.23
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$12,868.53	
July 1, 1887, outstanding liabilities	2,308.92	
		15,177.45
July 1, 1887, amount available		80,351.78

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Amount (estimated) required for completion of existing project.....	$46,620.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

Abstract of proposals for dredging 44,000 cubic yards, scow measurement, more or less, of soft clay, mud, and sand from the bar at Erie Harbor, Pennsylvania.

[Received and opened by Capt. F. A. Mahan, Corps of Engineers, at the United States Engineer office, Buffalo, N. Y., at 11 a. m. Thursday, September 30, 1886, under emergency, by sealed proposals invited by circular letter dated September 20, 1886.]

No.	Names and addresses of bidders.	Names and addresses of guarantors.	Rate per cubic yard.
			Cents.
1	James Roony, Toledo, Ohio	John C. Wuerfel and Minot J. Wilcox, Toledo, Ohio.	26
2	George Talbot, Buffalo, N. Y.....	Andrew Spaulding and Louis J. Bennett, Buffalo, N. Y.	38
3	Edwin H. French, Fulton, N. Y.....	George M. Case and Henry E. Michels, Fulton, N. Y.	39
4	J. Louis Linn, Erie, Pa	Porter B. Hickcox and William R. Haven, Buffalo, N. Y.	41

Abstract of proposals for furnishing timber, iron, and stone at Erie Harbor, Pennsylvania, opened at 12 m. on May 16, 1887.

	1. Laycock Lumber Company, Buffalo, N. Y.		2. G. Elias & Bro., Buffalo, N. Y.		3. Beals & Brown, Buffalo, N. Y.		4. Daniel McNaughton, Buffalo, N. Y.	
	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.
Piles (988 linear feet)	$0.16	$158.08	$0.18	$177.84	.....	.....	.....	.....
White oak (120 feet, B. M)	.....	.....	30.00	3.60	.....	.....	.....	.....
White pine (44,548 feet, B. M).....	25.00	1,113.70	21.00	935.51	.....	.....	.....	.....
Hemlock (32,007 feet, B. M)	12.50	400.09	9.50	304.07	.....	.....	.....	.....
Drift-bolts (2,927 pounds).....	.....	.....	.....	.....	$0.03 1/10	$90.74	$0.02 7/10	$79.03
Screw-bolts (23 pounds).....	.....	.....	.....	.....	.30	6.90	.27	6.21
Spikes (9 kegs)	.....	.....	.....	.....	4.87	43.83	4.55	40.35

COMMERCIAL STATISTICS.

Name of harbor, Erie, Pa.; collection district, Erie, Pa.; nearest work of defense, Fort Porter, N. Y.; nearest light-house, Erie, Pa.

The Erie Light stands on a bluff of the lake shore to the eastward, and just outside of Erie Harbor. It is a fixed white light of the third order. It is 128 feet above the level of the lake, and is visible at a distance of 19 miles. Its position is in latitude 42° 08′ 42″ north, and longitude 80° 03′ 46″ west.

The Presque Isle Beacon is at the east end of the north pier at the entrance to Presque Isle Bay. It is a fixed red light of the fourth order. It is 39½ feet above the level of the lake, and is visible at a distance of 12½ miles.

The Erie Range Beacon No. 1 is at the west end of the north pier at the entrance to Presque Isle Bay. It is a fixed white light of the sixth order. It is 16¾ feet above the level of the lake, and is visible at a distance of 9½ miles.

The Erie Range Beacon No. 2 is 908 feet from No. 1. It is a fixed white reflector light. It is 45 feet above the level of the lake, and is visible at a distance of 13 miles.

The Presque Isle Light is at the north shore of the peninsula, 3 miles by water westward from the entrance to Presque Isle Bay. It is of the fourth order, flashing alternately red or white with an interval of ten seconds between the flashes. It is 57 feet above the level of the lake, and is visible at a distance of 11 miles.

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Arrivals and departures of vessels during the year ending December 31, 1886.

Class.	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	659	679,518	656	675,912
Sailing vessels	186	94,288	176	87,511
Total	845	773,806	832	763,423

Revenue collected during the year ending December 31, 1886, $7,101.03; value of imports same year, $21,747; value of exports same year, none.

M M 2.

IMPROVEMENT OF DUNKIRK HARBOR, NEW YORK.

I relieved Maj. L. C. Overman, Corps of Engineers, of the charge of this harbor on September 23, 1886, in accordance with Special Orders, No. 188, paragraph 15, dated Headquarters of the Army, Adjutant-General's Office, August 14, 1886.

The improvement of this harbor was commenced in 1827, when the first appropriation therefor was made. The original project was much the same as that of the existing improvement, which comprises the formation of an artificial harbor in front of the city by means of a breakwater running nearly parallel with the shore, and a shore-arm or pier to the westward, with an opening between the pier and the breakwater. By 1832 the sum of $28,439.84 had been expended on the original plan, and the breakwater was then 2,564 feet long and the pier 14 feet long.

Various improvements and repairs were made from time to time, and by 1838 there had been completed 2,125 feet of breakwater and 300 feet of detached breakwater. In 1848 the breakwater was demolished.

Between 1848 and 1870 some portions of the work were renewed and others repaired, but in 1870 a Board of Engineers took into consideration the question of the radical improvement of the harbor. The Board recommended a plan which provided a breakwater 2,860 feet long, one part of which, 2,300 feet in length, was to be nearly parallel with the shore, the other part to be nearly parallel to the axis of the channel entrance, 560 feet long, and terminating at the position of the dumb beacon. Of the 2,300-foot section, 1,341 feet have been completed; none of the 560-foot section has been built.

OPERATIONS DURING THE FISCAL YEAR.

Up to the time of the transfer of this harbor to my charge no work had been done since the beginning of the fiscal year, owing to lack of funds, although repairs were much needed by both the east and west breakwaters.

A very severe gale that occurred on October 14, 1886, raised such a sea as to break completely through the west breakwater, making a breach about 75 feet wide. The same gale did a good deal of damage to the east breakwater, tearing off some of the deck plank and throwing out the stone ballast, breaking deck joists, ties, etc.

During the entire autumn there was a series of gales, each of which added to the damage already done. The breach in the west breakwater was widened to about 300 feet, being continuous westwardly from the beacon at the east end of the breakwater. Not only was the superstruct-

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ure carried completely away for this width, but also the foundation cribs, to depths varying from 4 to 7 feet below low water.

Contracts were made as soon as possible for the supply of materials for repairing the first damage done. The timber, however, could not be obtained before the winter set in. When the first supply was ordered the foundation cribs were still in place. So soon as it arrived men were at once put to work to frame it for the superstructure. But while this work was going on ice and gales were continuing the destruction of the cribs. When the ice cleared out of the harbor the cribs had been damaged to the extent described. The material framed could not be used until the damaged cribs should be rebuilt. Contracts for supplying the timber and iron required in rebuilding the cribs have been made as follows:

On June 23, with G. Elias & Bro., for timber.
On June 17, with D. McNaughton, for iron.

The reconstruction of the superstructure of the west breakwater will cost $9,433.82, or, say, $31.50 per running foot, provided that no further damage be done before the new superstructure shall be begun.

During the spring minor repairs to the east breakwater were carried on with such material as was on hand.

The whole of the east breakwater is in bad shape. The lake slope is rotten and should be replaced. The harbor face needs to be rebuilt to a great extent. The deck, both joists and plank, may last another year, but can hardly be expected to stand longer. To do this work will cost about $60 per running foot. The breakwater being 1,341 feet long, the cost will be about $80,000.

There remains yet to build of the east breakwater 1,519 running feet, in order to finish it out according to the existing project.

Of this work the extension westward, 560 feet long, is the most important and should receive early attention.

To do all this at $80 per running foot will cost $121,520.

Very extensive rock excavation and dredging is required at this harbor to make it fulfill the requirements of the present commerce of the lakes on a scale commensurate with the plan of the Board of Engineers of 1870. A 16-foot depth of channel and harbor would be required for the present class of vessels, whereas rock bottom occurs at 12½ feet depth.

The operations proposed for this harbor during the next fiscal year are:

(1) To replace the part of the cribs of the west breakwater destroyed during the winter.

(2) To renew as much of the superstructure as the material now on hand will permit.

(3) To continue the minor repairs of the east breakwater if there be any funds left after the other two pieces of work are done.

Money statement.

July 1, 1886, amount available		$35.27
Amount appropriated by act approved August 5, 1886		20,000.00
		20,035.27
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,161.09	
July 1, 1887, outstanding liabilities	4,574.95	
		11,736.04
July 1, 1887, amount available		8,299.23

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Amount (estimated) required for completion of existing project $40,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for timber, iron, and stone, for use at Dunkirk Harbor, New York.

[Opened at 12 o'clock meridian (eastern standard time), December 14, 1886, at the United States Engineer Office, Buffalo, N. Y., under advertisement of Capt. F. A. Mahan, Corps of Engineers, dated December 4, 1886.]

Articles.	1. G. Elias & Bro., Buffalo, N. Y.	*2. Fowler & Sons, Buffalo, N. Y.	3. Mark Packard, Buffalo, N. Y.
Stone:		Cents.	Cents.
100 to 150 cubic yards			
Iron:			
Drift-bolts, 500 (5,348 pounds) per pound		3.1	2.6
Spikes, 2,440 (814 pounds) do		2.85	2.6
Spikes, 180 (164 pounds) do		3.1	2.6
Lumber:			
White pine (50,820 feet, B. M.) per M		$27.00	
Oak (3,800 feet, B. M.) do		26.00	
Total cost	1,470.94	$194.07	$164.48

*No. 2. Bid informal.

Abstract of proposals for furnishing timber, iron, and stone, at Dunkirk Harbor, New York, opened at 12 m. on May 16, 1887.

	1. Laycock Lumber Company, Buffalo, N. Y.		2. G. Elias & Bro., Buffalo, N. Y.		3. Beals & Brown, Buffalo, N. Y.		4. Daniel McNaughton, Buffalo, N. Y.	
	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.
Drift-bolts (24,286 lbs)					$0.03 1/10	$752.87	$0.02 7/10	$655.72
Screw-bolts (180)					.40	72.00	.48	86.40
Spikes (29 kegs)					4.87	141.23	4.55	131.95
Stone (2,200 cubic yds)								
Hemlock (254,280 feet, B. M.)	$10.00	$2,542.80	$10.50	$2,669.94				

COMMERCIAL STATISTICS.

Dunkirk Harbor, New York, is in the collection district of Dunkirk. It is lighted by a third-order fixed white light varied by a white flash every 90 seconds and by a sixth-order fixed white beacon light. The main light is visible from a distance of 16¼ miles, and the beacon from a distance of 12½ miles.

There are three spar-buoys, one black, two red.

The nearest work of defense is Fort Porter, N. Y., 40 miles to the eastward.

The following table shows the commercial movement for the year ending December 31, 1886:

	Entered.			Cleared.		
	No.	Tonnage.	Mean.	No.	Tonnage.	Mean.
Steam vessels	6	732	122	6	739	123
Sailing vessels	3	738	246	3	738	246

Revenue collected for the year ending December 31, 1886, $201.38.

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M M 3.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

I relieved Capt. C. F. Palfrey, Corps of Engineers, of the charge of this work on September 30, 1886, in compliance with paragraph 15, Special Orders No. 188, dated Headquarters Assistant Adjutant-General's Office, Washington, August 14, 1886.

No work of any kind had been done from the beginning of the fiscal year to the time that Captain Palfrey turned the charge of the harbor over to me.

The first appropriation for this harbor was made on May 26, 1826, since which time the various sums appropriated and allotted amount to $1,963,480,41. (See Appendix A.)

HISTORY OF THE HARBOR.

A valuable and interesting history of Buffalo harbor was prepared by Mr. Maurice Kingsley, assistant engineer, while he was assistant to Captain Maguire. This report ends with June 30, 1884. To it I have added the compilation from July 1, 1884, to June 30, 1887. A copy of this report is forwarded herewith. (See Appendix B.)

PROJECT OF IMPROVEMENT.

The scheme of improvement as modified at various times provides for two piers, one on the north and one on the south side of the entrance to Buffalo Creek; for a masonry sea-wall running southwardly from the south pier; for a breakwater beginning abreast of the light-house on the south pier and keeping a southeasterly direction about half a mile from and parallel with the shore; and for a pier or shore-arm of the breakwater to close the southeasterly end of the space included between the shore and the main breakwater.

THE PIERS.

The piers at the mouth of the creek, known as the north pier and south or light-house pier, were long since completed. The north pier is occupied by the coal pockets of the Delaware, Lackawanna and Western Railway Company under certain conditions approved by the War Department. The south pier is unincumbered. The Buffalo light is at the end of the pier in latitude 42° 52′ 40″ north and longitude 78° 53′ 24″ west.

The piers are in good condition.

The heavy gale of October 14, 1886, carried away the timber deck of the cribs which protect the foundation of the light-house on the harbor side. The stone ballast of the cribs was left unharmed. The deck, both joists and planks, was wholly rotten.

I do not consider that any repairs will be needed this season.

THE BREAKWATER.

No work was done to the breakwater from the beginning of the fiscal year up to the time of my relieving Captain Palfrey at the end of September.

Gale of October 14, 1886.—Great damage was done to this structure by the gale of October 14, 1886, the heaviest experienced since November

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16, 1869. The wind was from the southwest. It reached at one time a velocity of 70 miles an hour. The level of the lake surface was raised to a height of 7.30 feet above standard low water. For a length of 1,910 feet, beginning at the north end, almost the entire shore face of the breakwater was pushed out of place. The ends of the cross-ties had become so rotten that in many cases the wood of the dovetails stripped off. In parts of the wall the timber was held together by the drift-bolts, the wall being bent over at some points to such an extent as to form nearly a quadrant. Twenty-five pockets on the land side, and eleven on the lake side, were emptied of stone to a greater or less extent, the majority having none left.

One noticeable feature of this gale was its effect on the deck of the breakwater, which is laid in two ways. In some parts the planks are put down with an interval of about 2 inches between them; in others they are laid close up each against the other. In the open-laid parts very few planks were loosened and under them the deck-joists were found to be so rotten that the spikes had no hold. In the close-laid parts there was hardly a plank unstarted except in the newest portions of the work and there the number of loosened ends was remarkable. The inference is plain, the deck should be so laid as to leave a space at least an inch and a half wide between the planks.

The pockets which had been emptied were filled with large stones from the old sea-wall so as to last through the winter.

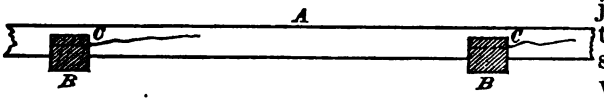
Damage by ice.—The ice of the past season did much damage, and revealed three defects in the mode of construction.

First defect.—In all the work done during the last four or five years half of the cross-walls only of both cribs and superstructure have been built solid, the other half having a 12-inch space between each timber and those next above and below it. This latter mode of construction is economical of timber and is of sufficient strength when water only is in question. But when resistance to ice is considered, the experience of last winter shows that this saving of timber is dearly purchased.

The "shove" of last winter is the heaviest of which I can find any account. At six or eight points on top of the south parapet the ice was forced up into piles 30 feet or more in height. The weight of this mass crushed in the deck of the parapet, the damage extending for a distance of about 500 feet, most of it continuous and all of it in the parts of the work not more than two or three years old.

Second defect.—All of the deck-joists are dapped on the cross-ties. Wherever they broke they all gave way in the same manner, viz., by splitting at the top of the "dap" made in them.

This can be best understood from the side sketch where A is the deck-joist, B B are cross-ties, and C C are the splits or lines in which the deck-joists gave way.



Third defect.—The stone ballast stops at a foot below the bottom of the deck-planks. Had it come close up to them there would have been a much better resistance.

The lake face of the breakwater was crushed in by the ice at twenty-eight places just at the level of the water. Every break except two occurred where the end of two timbers butted against each other.

While this could be prevented, it would not be economical to put the additional strengthening required.

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The pressure resulting from the "ice shove" must have been very great. At one place two tiers of 12 by 12 inch white pine were crushed in just above the water-line. The mass of stone lying behind and against them was crowded back so far that the face timbers which were driven in now lie about 3 feet back from their proper place. The cross-ties were literally telescoped on themselves for a length of about 3 feet. What their condition may be further in I cannot say for they are not yet uncovered beyond this distance from the face.

The southeast end of the structure was the most injured. During an at all heavy southwest blow the current sets around that part of the breakwater with great force. The timbers at the end were cut by the ice through to the drift-bolts; the part remaining, having no support, gave way. The stone in this corner was firmly cemented together by ice. It was dug out so that it should not interfere with new work in the future by falling through the breach when the ice melted.

Since the ice disappeared the work of minor repairs has gone on steadily. It has been done by day's labor. These repairs are a most unsatisfactory sort of work. It shows for nothing when done and requires a great deal of time and labor on account of the quantity of material that has to be moved and replaced.

Plan for new superstructure.—The dilapidated condition in which the north end of the breakwater was left after the storm of October 14, 1886, made evident the fact that the reconstruction of the superstructure was an absolute necessity.

The question arose as to the best character of material wherewith to rebuild. Stone is much more expensive in first cost than wood; at the same time it is more durable.

On December 15, 1886, a plan for a new superstructure of concrete faced with stone was submitted to the Chief of Engineers. This plan was laid before the Board of Engineers for revision. They recommended that 1,000 linear feet should be built; 500 with stone facing and 500 with a facing of Portland cement concrete. This was accepted by the Chief of Engineers, except as to the length of concrete facing which he reduced to 250 feet. The changes made by the Chief of Engineers were adopted by the honorable the Secretary of War and the construction of the new superstructure was ordered, the work to be done by day's labor and the materials to be bought by contract.

The plan as finally approved is as follows:

(1) The timber cribs of the foundation are to be cut down to 2 feet below mean low water.

(2) On the razeed cribs is to be built a masonry foundation, 5 feet high, of the same width as the cribs, vertical on the harbor side and with a slope of 5 on 3 on the lake side.

(3) On this structure is a parapet 20 feet wide at bottom, 17 feet wide at top, and 9 feet high, the slope of both the harbor and lake sides being the same, 6 on 1. The lower edge of the lake side of the parapet coincides with the upper edge of the lake side of the foundation.

The new superstructure is to be built in two ways:

(1) The inside mass of natural cement concrete is to be covered with stone masonry of varying thickness. On the lake face 3 feet, on top 2 feet for 5 feet back from the lake face, the remainder of the top 1 foot; the harbor face of the parapet 2 feet and the harbor face of the foundation 2.5 feet; the top face of the foundation for a width of 11.5 feet to be uncovered.

(2) The concrete mass is to be covered on all sides with a layer of Portland cement concrete 3 feet thick.

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It is expected to begin this work early in the coming fiscal year.

The tearing down of the old timber superstructure has been begun, and a length of 50 feet is now ready to receive the concrete. All stone of such size that it can be used solid is set aside to be placed bodily in the concrete. Such of small size as is too large to be used in the concrete is broken by hand to the proper size. The stone is very hard. A man averages 2¾ yards per day.

The sand, pebbles, natural cement, and iron for the new superstructure are all ordered.

It is expected that the laying of the concrete will begin not later than July 20.

The minor repairs to the breakwater during the past year have cost—

For materials	$644.52
For labor	6,291.32

The cost of the repairs is only approximate in its distribution, as the data for its accurate determination were destroyed by fire with other office records.

Repairs to the breakwater.—At the present time the permanent repairs authorized for the breakwater are estimated to cost in round numbers $160 per running foot. These repairs will cover a length of 750 feet. An additional length of 1,160 feet of the breakwater is now in ruins more or less complete. A length of 1,500 feet more still holds together, but the timber is very rotten. It is liable to go to pieces with any heavy blow. We have thus 2,660 linear feet of the structure in urgent need of repair. At the above estimated price these repairs will cost $425,600.

The minor repairs cannot be closely estimated. Experience this year shows that when these repairs are begun it is impossible to tell where they will end. So much of the structure is out of sight that no correct idea of the extent of the work required can be formed until the inside timbers are exposed. Judging by the work done to date and the experience thus obtained there will be needed for this class of repairs $20,000.

Taking these two items together, it is found that the sum of $445,600 is needed for necessary repairs.

Extending the breakwater.—The breakwater lacks 1,250.2 feet of its full length, as decided on by the Board of Engineers in 1874. The cost of this, at $110 per running foot, will be $137,522. This work can be done without difficulty in one season.

The shore-arm of the breakwater is about 800 feet long. It needs to be extended 3,300 feet in order to complete the present plan. To do this will cost, at $100 per running foot, $330,000. This work may be postponed for another year, as the renewal of the superstructure of the breakwater and the extension of its main body are much more important. Then, too, in view of the rapidly increasing business of this port, it is a question whether the harbor formed on the present plan will not prove before long to be too small, and thus make the removal of the shore-arm a necessity and its construction uneconomical.

SAND-CATCH OR PILE-PIER.

Some slight repairs were needed to this structure on account of damages it received during the storm of October 14, 1886. They were made by day's labor and cost approximately—

For materials	$150
For labor	200

No further work will probably be needed during the next fiscal year.

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BOAT-HOUSE.

During the gale of October 14, 1886, the schooner *Mystic Star* ran into and demolished one corner of the boat-house. No fault can be attached to the vessel, as she had become unmanageable in the storm.

The repairs cost approximately:

For materials	$200
For labor	250

PROPOSED OPERATIONS.

The work laid out for the coming year is the reconstruction of the superstructure of the breakwater. The part to be rebuilt is 750 feet in length. Of this 250 feet will be faced with Portland cement concrete and 500 feet will be faced with stone according to the principles hereinbefore stated.

The concrete-faced part will first be built. It will begin at the north end of the breakwater. The superstructure will be divided into sections of the same length as the foundation-cribs. Each section will be completed by itself before a second shall have been begun.

During the past fall and winter a great deal of information relating to the commerce and shipping of Buffalo had been collected. It was all destroyed in the fire of March 15, 1887. Since then an effort has been made to replace it, but with only partial success.

Among the data lost was a very complete list of all the vessels plying to this port. This list cannot be replaced in the spring or summer, as vessel owners are then too busy to make up the necessary information.

The most important items of imports by lake are grain and timber.

The earliest data I have been able to find relating to grain receipts begin with 1836. In that year there were brought by lake to Buffalo 139,178 barrels of flour, 304,090 bushels of wheat, 204,255 bushels of corn, 28,640 bushels of oats, 4,876 bushels of barley, and 15,000 bushels of rye. These figures have increased, with many ups and downs between times, in 1886 to 4,582,190 barrels of flour, 41,430,440 bushels of wheat, 29,155,370 bushels of corn, 1,014,670 of oats, 787,730 of barley, and 126,630 of rye.

The year 1886 shows the highest receipts of wheat and flour. Corn reached its maximum, 62,214,417 bushels, in 1880; oats in 1864, 11,682,637 bushels; barley in 1872, 3,088,925 bushels; rye in 1883 with 2,820,830 bushels.

The year 1880 showed the highest total receipts of all kinds of grain, there having been received 105,453,372 bushels, exclusive of flour in barrels. If flour be included, the total rises to 112,042,927 bushels.

The year 1886 shows the next maximum of total receipts, 72,514,840 bushels of grain, not counting flour, or 95,425,790 bushels if flour be included.

On sheet C of the accompanying tracings are given the curves of wheat and oats received each year from 1836 to 1886 inclusive. On sheet D is the curve of corn.

I find the data for timber imports by lake very meager. They cover only the years 1884, 1885, and 1886. The curve of lumber is given on sheet D of the tracings.

The receipts by lake of the various sorts of timber products are given in Table I of the commercial statistics.

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The general imports by lake, other than those given in Table I, are shown in Tables II and III. In Table II they are compared with those of 1885. In Table III they are given without comparison for lack of previous data.

The exports by lake are not of so great importance as the imports, so far as mere tonnage is concerned.

The most considerable item is that of coal, which since 1878 has been steadily increasing, except in 1884, when it fell off slightly, in common with almost everything else after the commercial flurry of 1883.

The position occupied by Buffalo at the eastern terminus of lake navigation naturally causes a great commercial movement. In 1886 one-seventh of the entire wheat crop of the United States was received here. This movement is constantly growing. It is made manifest by the steady increase in the size of the vessels plying to this port, by the enlargement, slowly but surely taking place, of the Erie Canal, and by the additional facilities for business with which the railways are providing themselves.

It is not many years since a vessel carrying 20,000 bushels of grain was considered a large craft. To-day vessels come to this port with cargoes of 70, 80, and even 100,000 bushels without exciting comment.

In 1836 the first railway coming to Buffalo was opened. There are now, exclusive of purely local roads, eleven railways leading to this city from north, south, east, and west. These railways own 6,920.68 miles of road, and lease 4,825.49 miles; in all, 11,746.17 miles. Their tracks within the city reach the sum of 436 miles; soon to be increased to 660.

An interesting study might be made of the value of the Erie Canal as an export route from Buffalo. Such a study is outside of the object of this report. It may be well, however, to note the comparative amounts of grain, meal, and flour received by various routes at New York during the year ending December 31, 1886.

It will be seen by Table IV that the Erie Canal carried to New York last year one-third of all the grain received there, and this notwithstanding the fact that the canal was open during seven months of the year only.

Accompanying this report are eight tracings, marked—

"Buffalo Harbor, New York," showing the harbor, the works for the harbor, and the grain elevators, with their capacities.

C. Showing the imports by lake of wheat and oats from 1836 to 1886, both inclusive.

D. Showing the imports by lake of corn from 1836 to 1886, both inclusive.

E. Showing the exportation by lake of coal, cement, railroad iron, and salt.

F. Arrivals and departures of vessels.

G. The total and average tonnage of arriving and departing vessels.

H. The revenues collected at this port since 1857, and the various appropriations made for construction and maintenance.

I. Showing the variations, amounts, and frequency of the winds.

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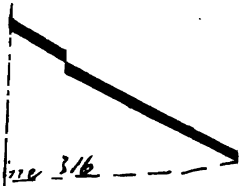

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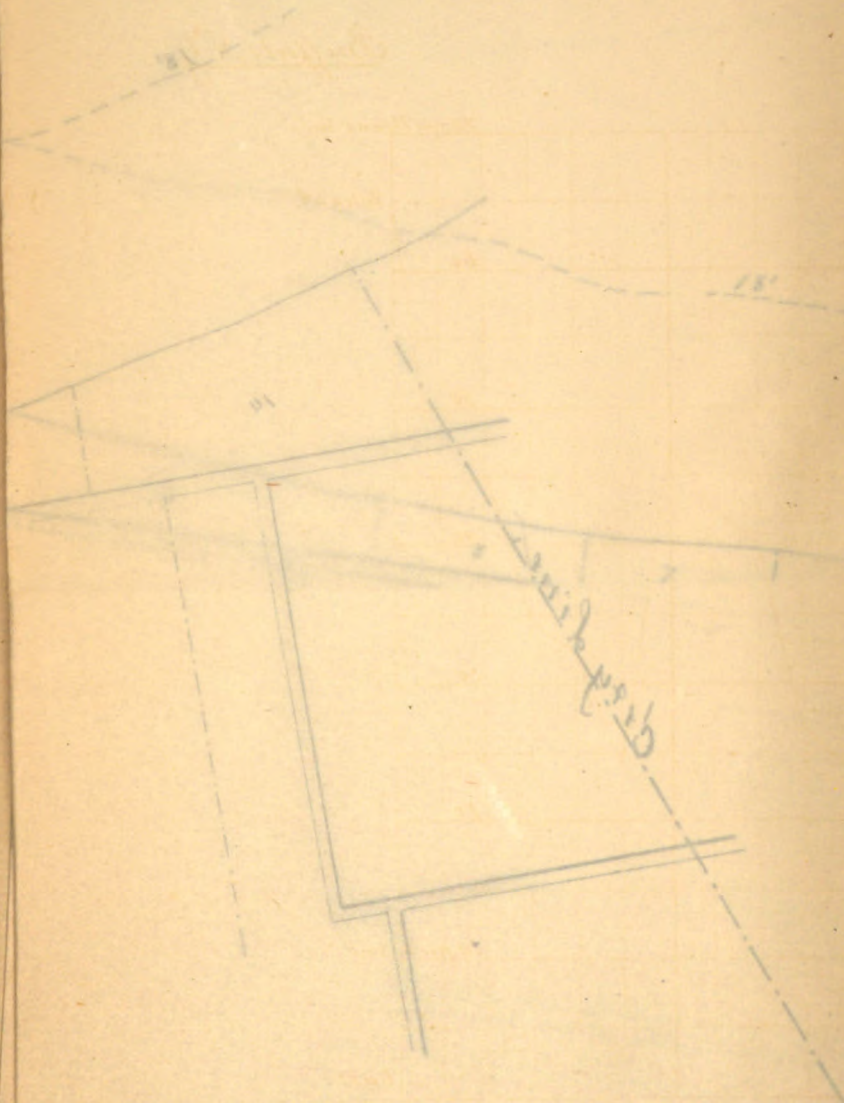

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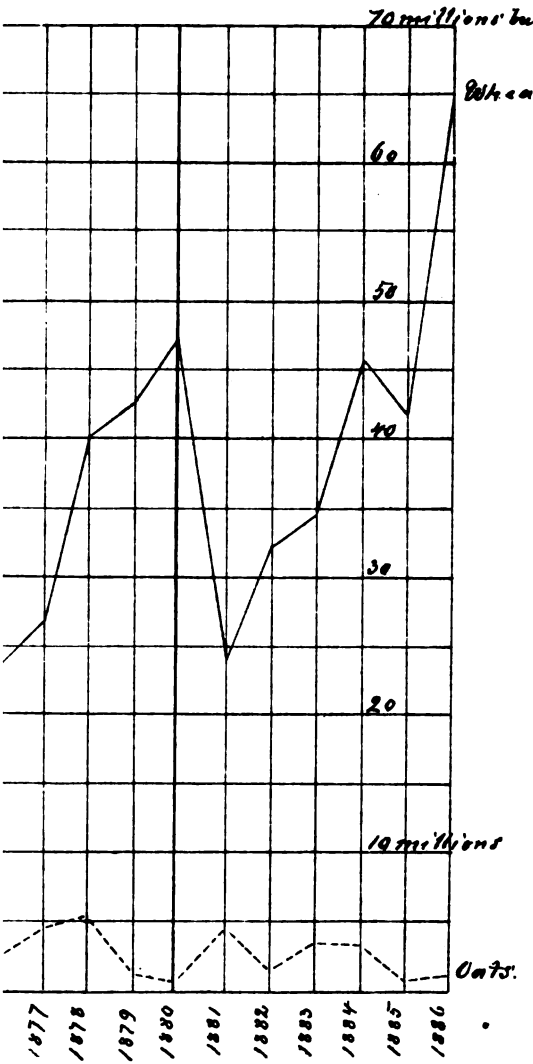
Buffalo N.Y.



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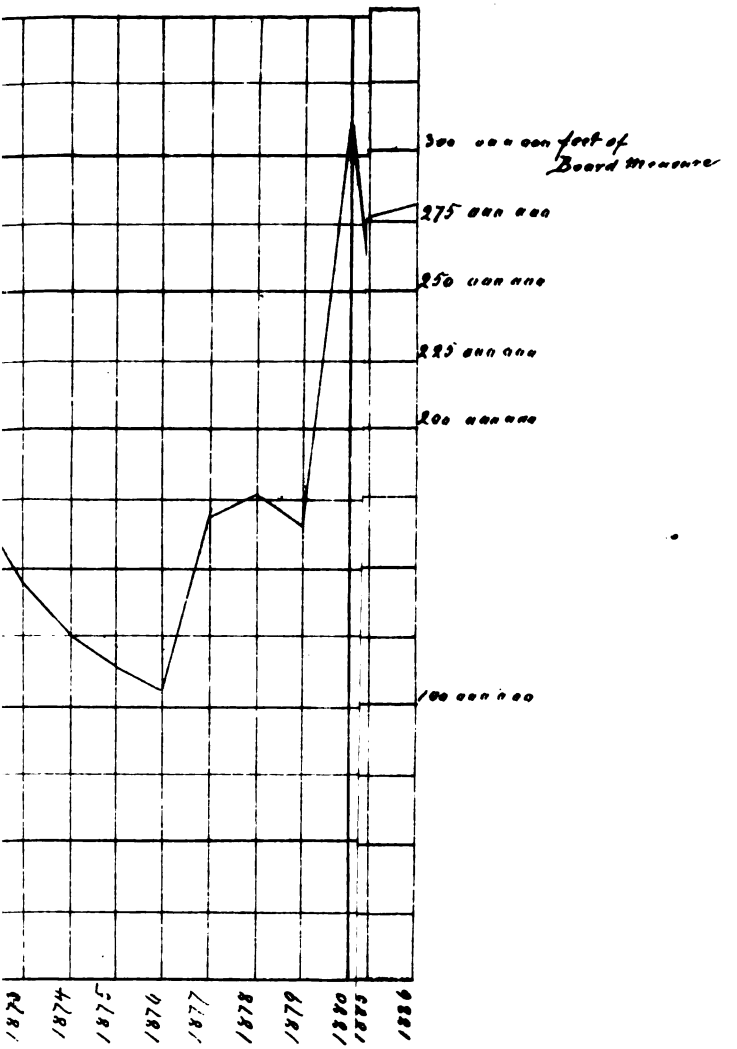

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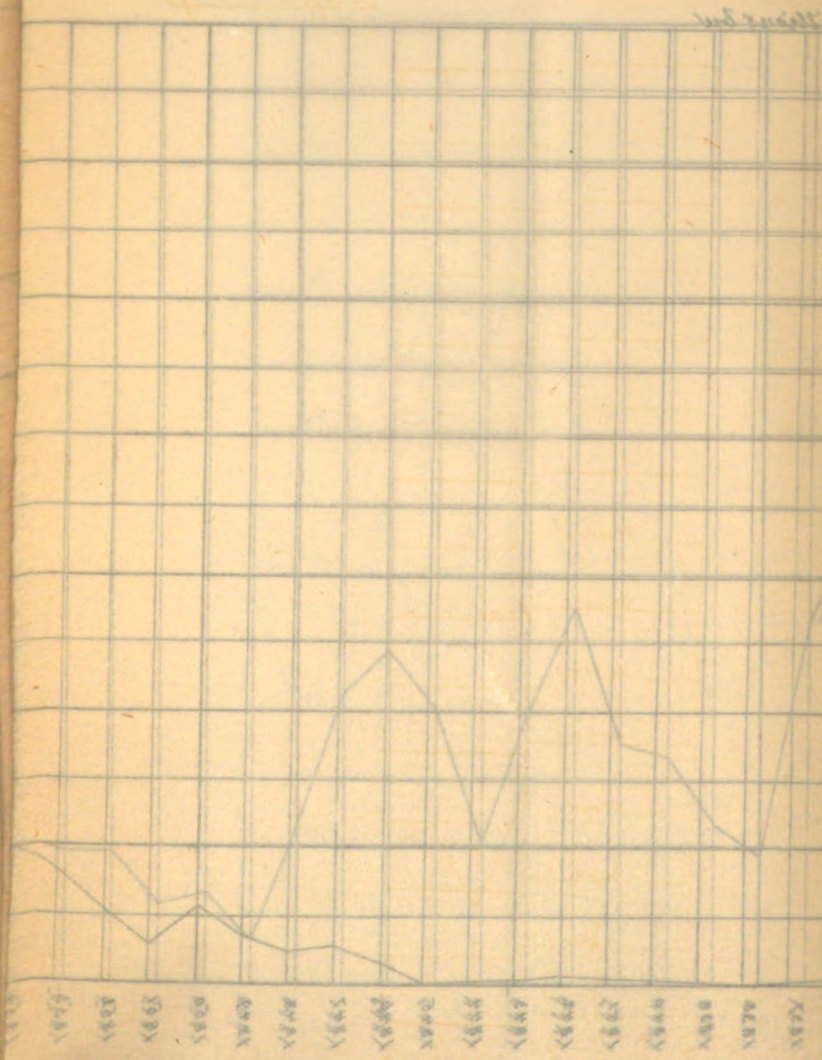

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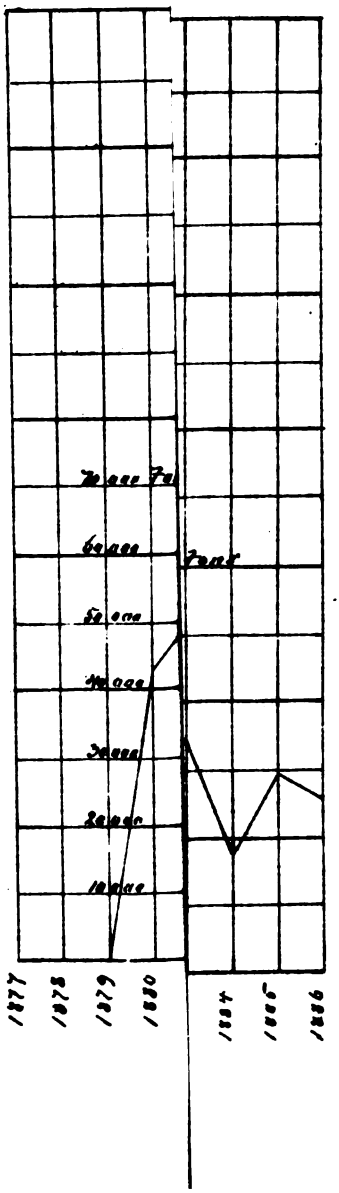
Rail 3

Buffalo N.Y.



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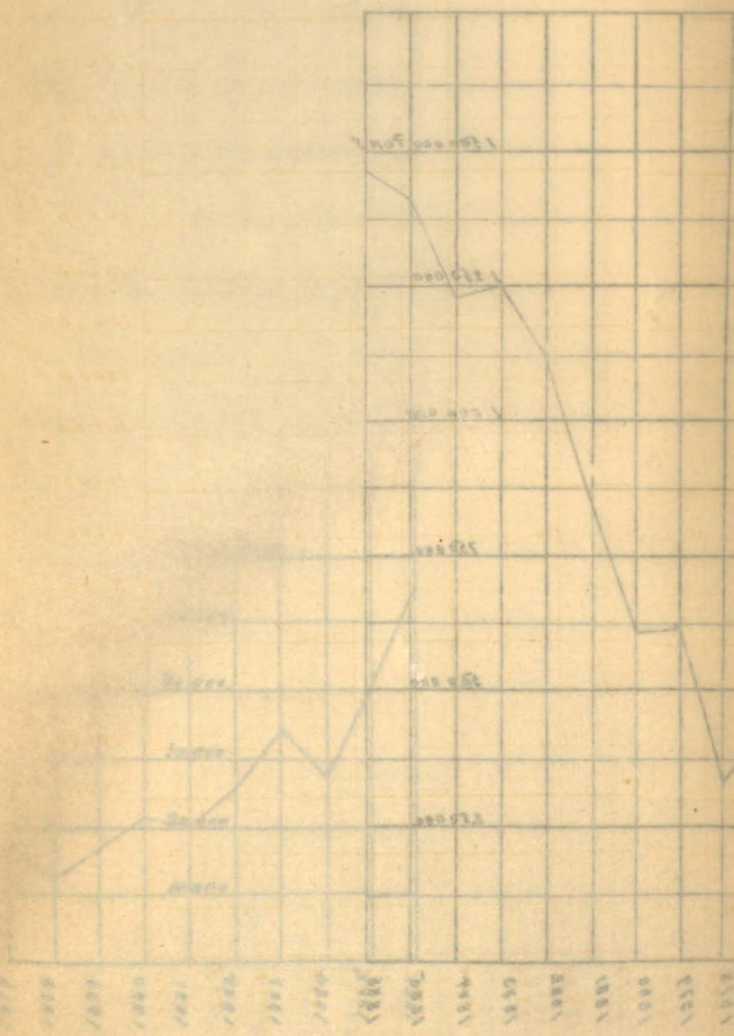

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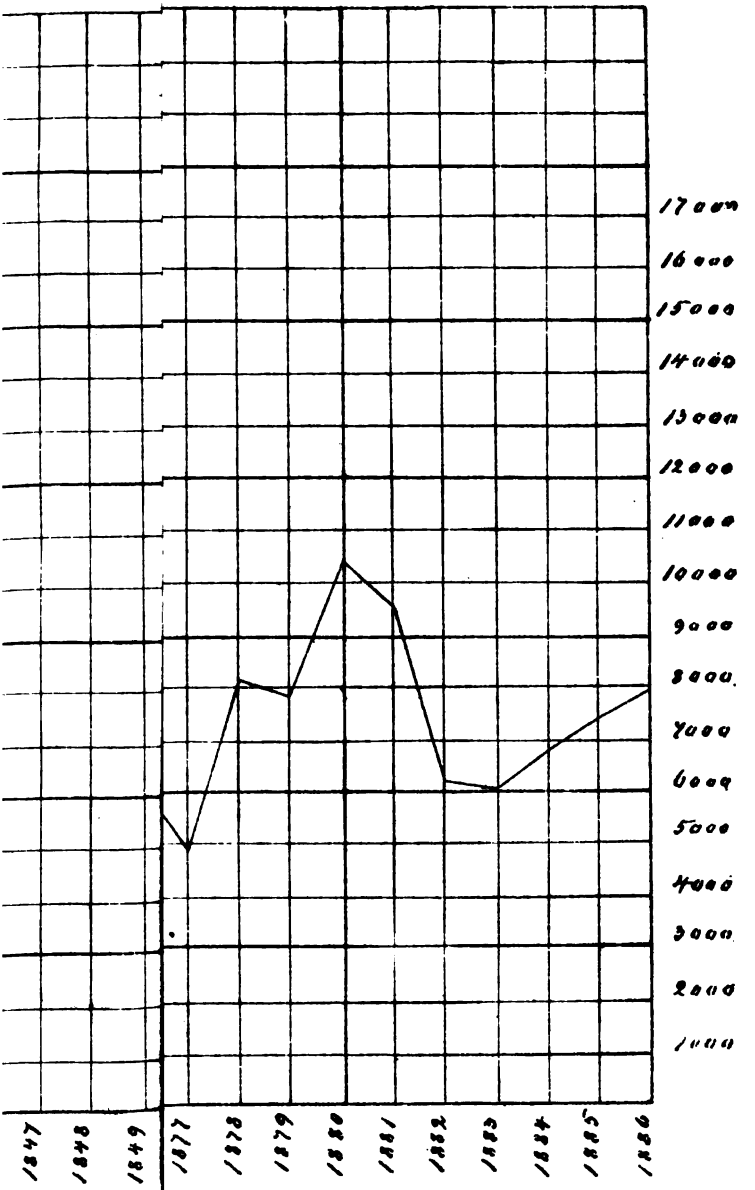

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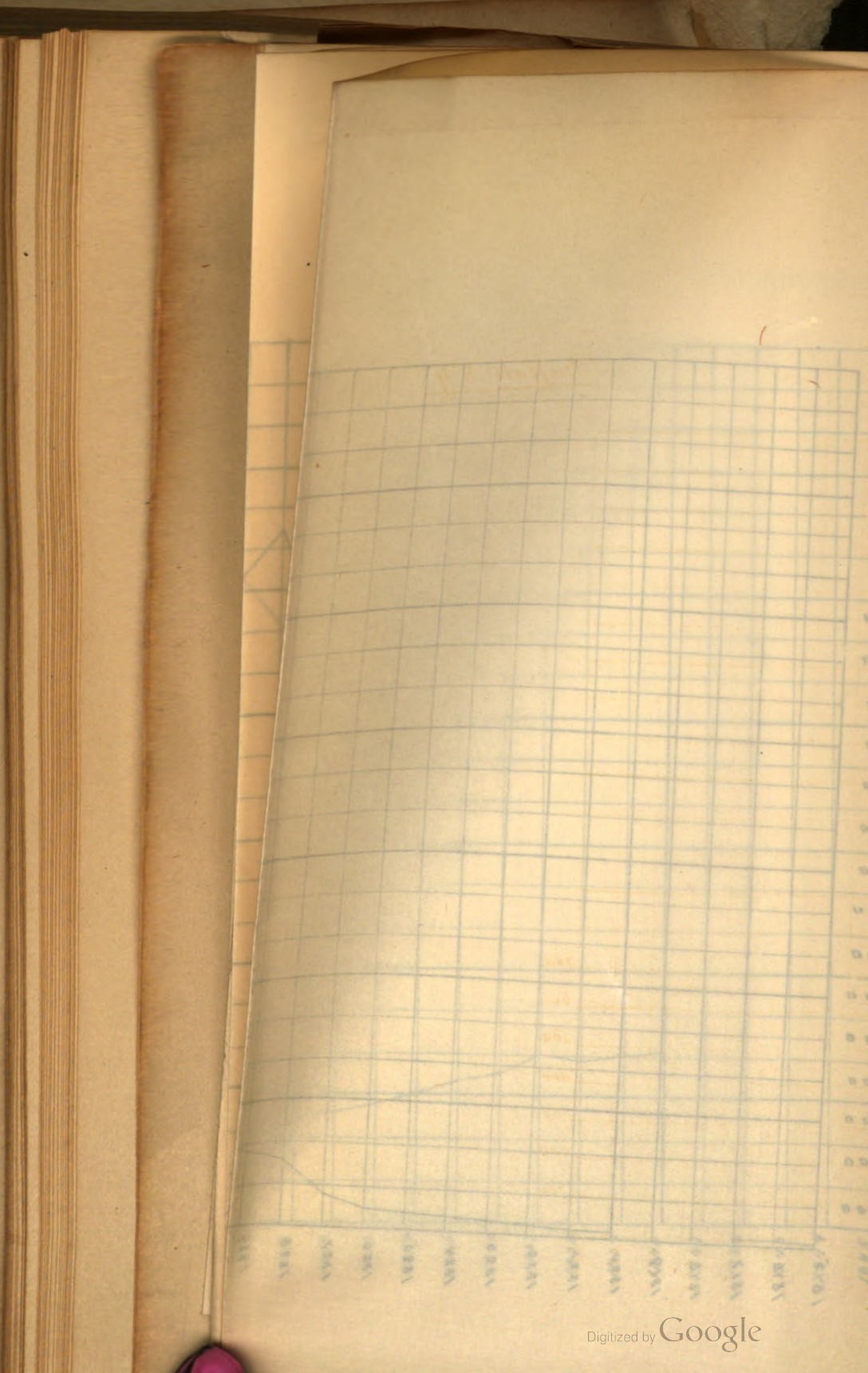
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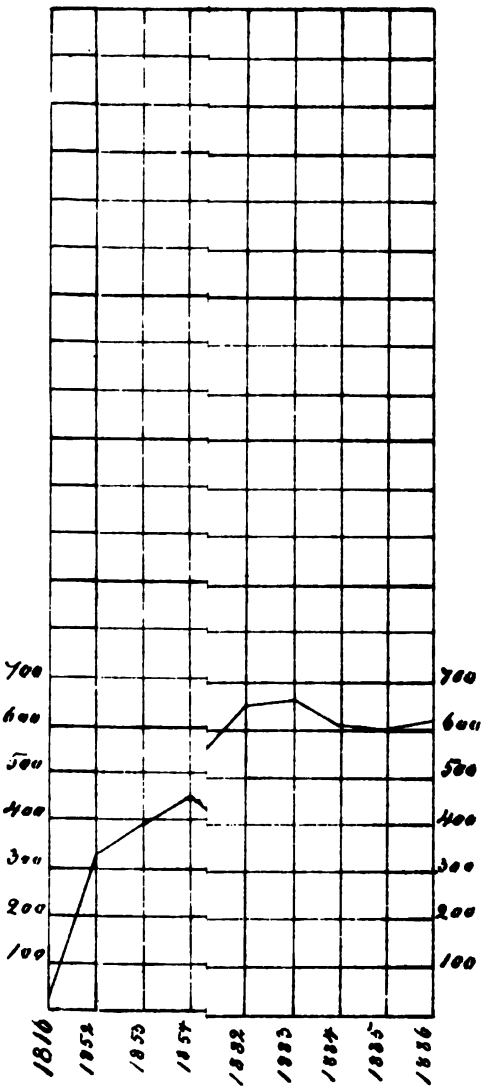
Buffalo N.Y.



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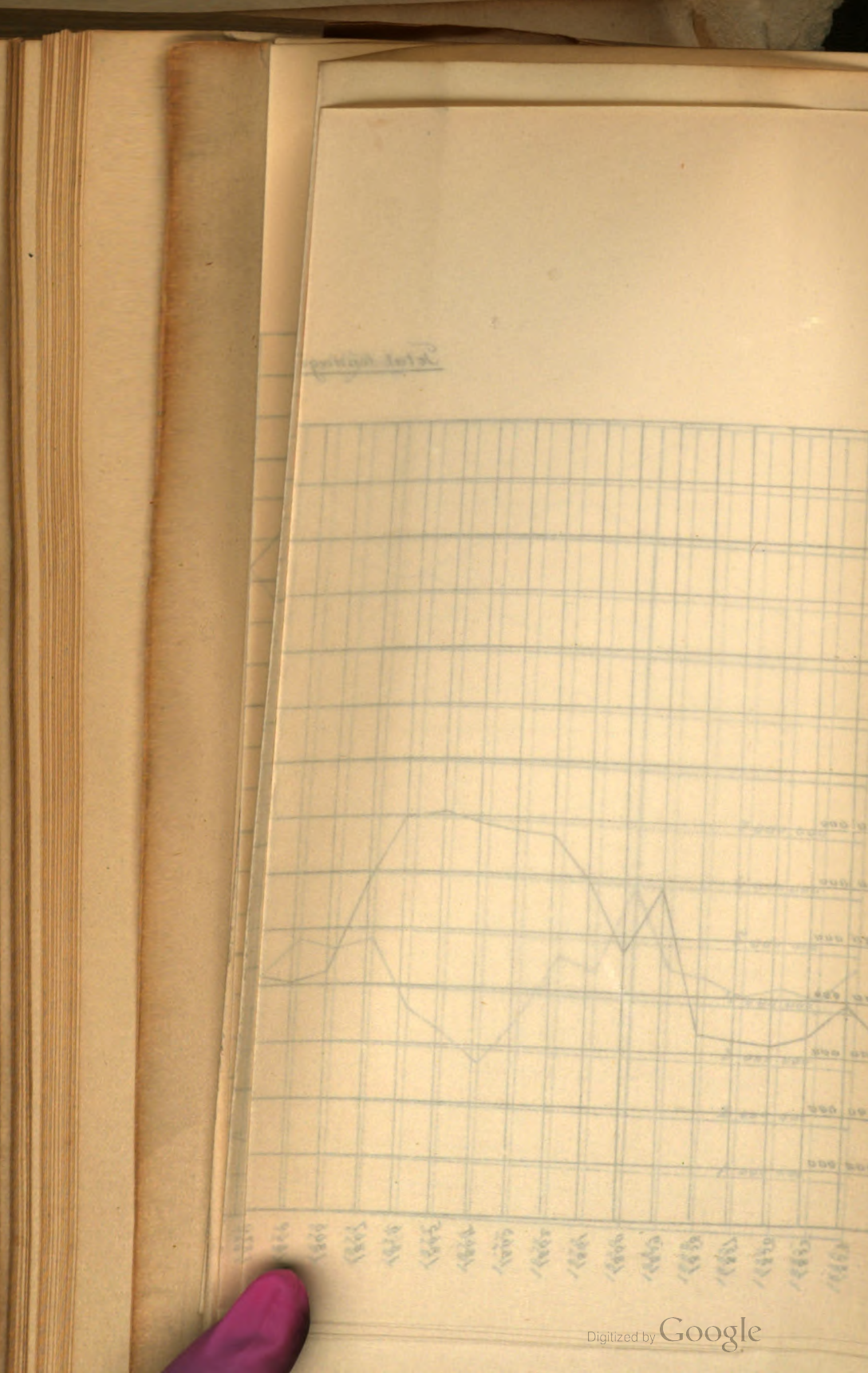
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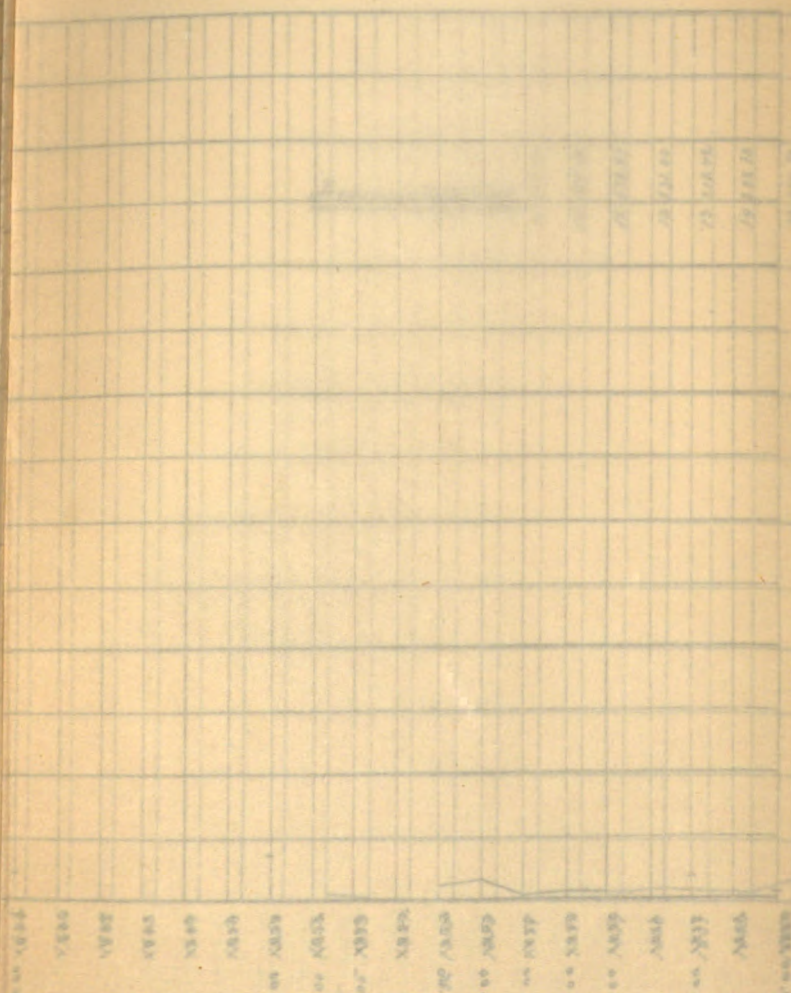

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Percentage.

	Calm			N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calms
97	129	4368	Spring	1.29	3.14	2.13	1.08	2.52	8.24	3.13	1.69	0.71
68	145	4396	Summer	1.70	2.69	2.89	1.06	2.95	7.86	3.64	2.11	0.84
55	76	4416	Fall	0.69	2.73	2.23	1.49	2.89	6.19	6.11	2.48	0.43
34	101	4312	Winter	1.16	2.87	2.13	1.16	2.34	7.05	5.44	1.92	0.57
29	445	17492		4.79	11.43	9.78	4.79	10.70	30.44	18.32	8.20	2.55

Condensed Wind Observations

from

January 1st 1871 to December 31st 1886

Buffalo N.Y.

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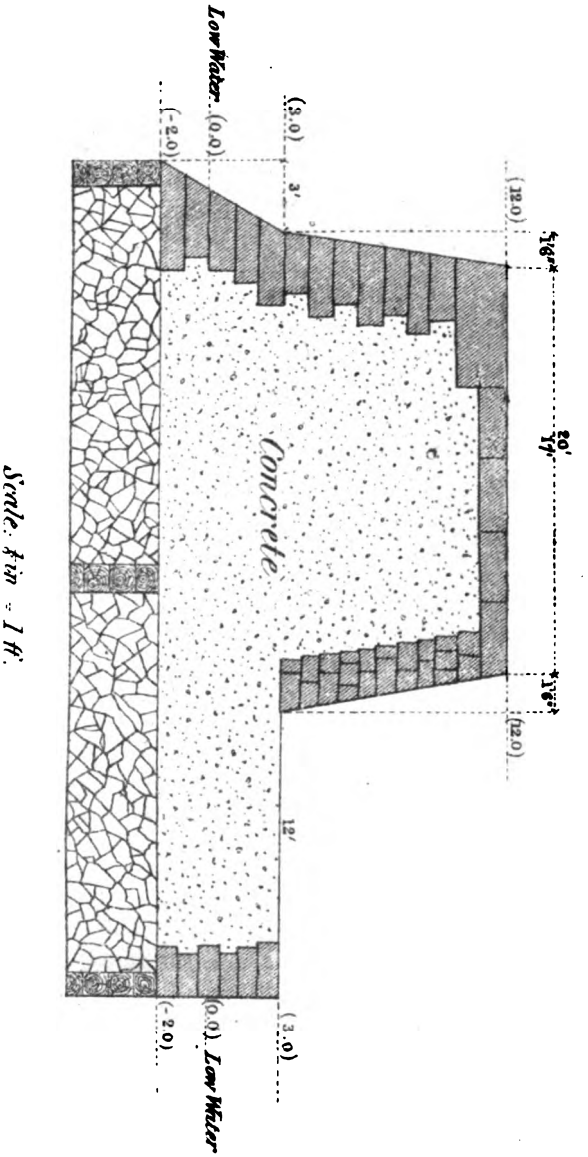

Nº1.

Cross Section of Concrete Superstructure, faced with Masonry, for

BREAKWATER, BUFFALO HARBOR, N.Y.

recommended by the Board of Engineers in 2nd indorsement, dated Feb. 2. 1887 on letter of Capt. F.A. Mahan, Corps of Engineers, to the Chief of Engineers, dated Dec. 15, 1886.

Thos. Lincoln Casey
Colonel, Corps of Engineers.

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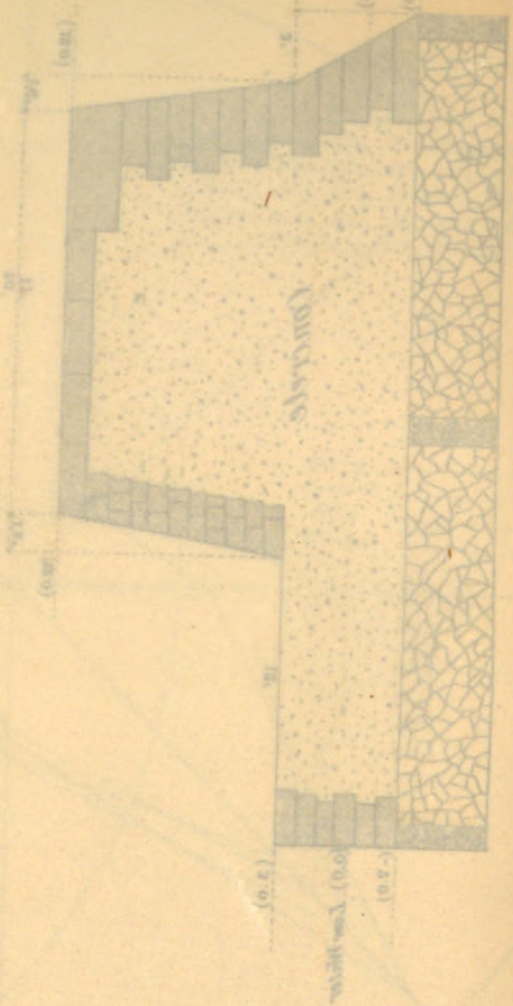

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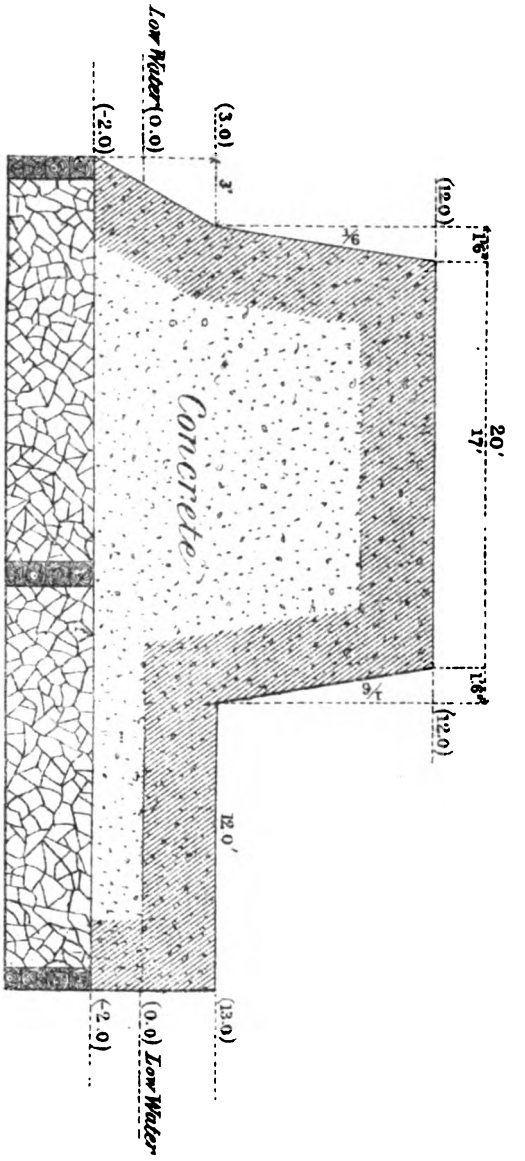

Scale: ½ in. = 1 ft.

No. 2.

Cross Section of Superstructure, entirely of Concrete, for

BREAKWATER, BUFFALO HARBOR, N.Y.

recommended by the Board of Engineers in 2nd indorsement, dated Feb. 2, 1887 on letter of Capt. F. A. Mahan, Corps of Engineers, to the Chief of Engineers, dated Dec. 15, 1886.

Note: The part shaded, to be of rich Portland Cement Concrete.

Thos. Lincoln Casey
Colonel, Corps of Engineers.

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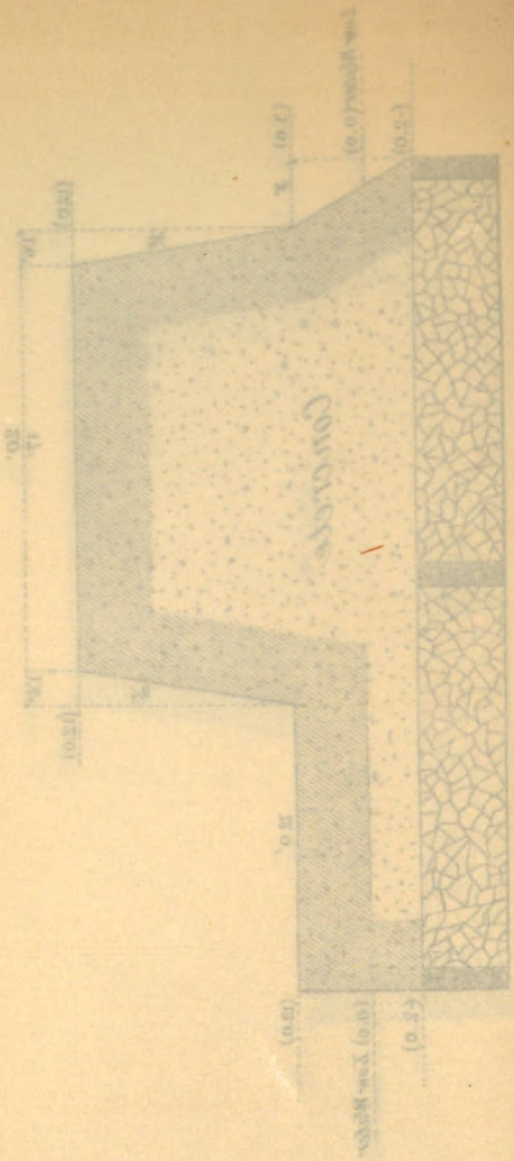

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L.—*Statement of appropriations and allotments made for improving harbor at Buffalo, N. Y., from May 26, 1826, to the present time.*

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 26, 1826	$15,000.00	$15,000.00	April 10, 1869	†89,100.00	$635,495.37
May 19, 1828	34,206.00	49,206.00	July 10, 1870	80,000.00	715,495.37
April 23, 1830	15,488.00	64,694.00	March 3, 1871	100,000.00	815,495.37
March 2, 1831	12,900.00	77,594.00	June 10, 1872	‡98,485.04	913,980.41
July 3, 1832	10,300.00	87,894.00	March 3, 1873	75,000.00	788,980.41
March 2, 1833	31,700.00	119,594.00	February 23, 1874	20,000.00	1,008,980.41
June 28, 1834	20,000.00	139,594.00	June 23, 1874	75,000.00	1,083,980.41
July 7, 1838	*68,500.00	208,094.00	March 3, 1875	100,000.00	1,183,980.41
June 11, 1844	40,000.00	248,094.00	August 4, 1877	85,000.00	1,268,980.41
August 30, 1852	14,000.00	262,094.00	June 18, 1878	80,000.00	1,348,980.41
March 3, 1853	349.05	262,443.05	March 3, 1879	100,000.00	1,448,980.41
March 2, 1855	452.32	262,895.37	June 14, 1880	90,000.00	1,538,980.41
June 28, 1864	†15,000.00	277,895.37	March 3, 1881	90,000.00	1,628,980.41
July 2, 1864	37,500.00	315,395.37	August 2, 1882	125,000.00	1,753,980.41
June 23, 1866	131,000.00	446,395.37	July 5, 1884	100,000.00	1,853,980.41
March 2, 1867	100,000.00	546,395.37	August 5, 1886	112,500.00	1,966,480.41

* Two appropriations.
† Allotment from general bill.
‡ Includes $23,485.04 which had reverted to the Treasury and was reappropriated.

The total amount appropriated and allotted for this harbor is $1,966,480.41, of which $1,857,051.06, exclusive of outstanding liabilities, have been expended.

The amount expended on the present project, from its adoption in 1874 to June 30, 1887, is $833,970.64.

Money statement.

July 1, 1886, amount available		$9,307.67
Amount deposited to balance account		2.00
Amount appropriated by act approved August 5, 1886		112,500.00
		121,809.67
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$12,380.32	
July 1, 1887, outstanding liabilities	22,468.59	
		34,848.91
July 1, 1887, amount available		86,960.76
Amount (estimated) required for completion of existing project		1,117,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of proposals for timber, iron, stone, and miscellaneous articles required in repairing breakwater, sand-catch, and boat-house at Buffalo, N. Y.

[Opened January 13, 1887, at the United States Engineer Office, Buffalo, N. Y., under advertisement of Capt. F. A. Mahan, Corps of Engineers, dated January 3, 1887.]

No.	Names and addresses of bidders.	Timber.		Iron.		Stone (200 cubic yards) per cubic yard.	Shingles (2 bunches) per bunch.
		Oak (15.556 ft., B. M.) per M.	White pine (17.597 ft., B. M.) per M.	Drift-bolts (911 lbs.) per pound.	Spikes (1.050 lbs.) per pound.		
				Cents.	Cents.		
1	G. Elias & Brother, Buffalo, N. Y	$28	*$27 †28				$0.95
2	Richard Walter, Buffalo, N. Y					‡$0.85	
3	Beals & Brown, Buffalo, N. Y			4	4		
4	Will B. Hull, Buffalo, N. Y	33					
5	Andrew J. Packard, Buffalo, N. Y	26				1.40	‖4.00
6	Mark Packard, Buffalo, N. Y			3	3½		
7	Pliny B. McNaughton, Buffalo, N. Y			2.8	2.95		
8	§Dewitt Clinton Welch, Buffalo, N. Y	26	23				‖3.50

No.	Name and address of bidders.	One window-sash (6 lights) per light.	Glass (6 lights 10 by 15 inches) per light.	Putty (4 pounds) per pound.	Nails.			Glaziers' points (1 paper).	Total amount of bid.
					3-penny (30 lbs.) per pound.	8-penny (30 lbs.) per pound.	20-penny (25 lbs.) per pound.		
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	
1	G. Elias & Brother, Buffalo, N. Y								$916.30
2	Richard Walter, Buffalo, N. Y								170 00
3	Beals & Brown, Buffalo, N. Y			5	4	4	4	10	71.64
4	Will B. Hull, Buffalo, N. Y								882.95
5	Andrew J. Packard, Buffalo, N. Y	12	8	5	5	5	5	15	1,149.53
6	Mark Packard, Buffalo, N. Y								64.08
7	Pliny B. McNaughton, Buffalo, N. Y								56.48
8	§ Dewitt Clinton Welch, Buffalo, N. Y								810.99

*$27 per M on 13.935 feet, B. M.
†$28 per M on 3.662 feet, B. M.
‡ This bid was made for the whole lot of 200 cubic yards. The price per yard was calculated with the result of 85 cents per yard.
§ Bid received at 2 p. m., January 13, 1887.
‖ Per M.

All bids for timber were rejected.

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Abstract of proposals for furnishing timber, iron, etc., at Buffalo Harbor, New York.

[Opened at 12 m. on May 16, 1887, at the United States Engineer Office, Buffalo, N. Y., under advertisement of Capt. F. A. Mahan, Corps of Engineers, dated May 5, 1887.]

Material.	1. Laycock Lumber Company, Buffalo, N. Y.		2. G. Elias & Bro., Buffalo, N. Y.		3. Beals & Brown, Buffalo, N. Y.		4. Daniel McNaughton, Buffalo, N. Y.	
	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.	Price per unit.	Total.
Piles (1,272 linear feet)	$0.25	$318.00	$0.25	318.00	.....	.....	.....	.....
White oak (5,728 feet, B. M.)	26.00	148.93	24.00	137.47	.....	.....	.....	.....
White pine (119,028 feet, B. M.)	25.00	2,998.20	21.00	2,518.49	.....	.....	.....	.....
Drift-bolts (3,466 pounds)	.....	.....	.....	.....	$0.07 1/10	$107.45	$0.02 1/10	$93.58
Screw-bolts (450)	.....	.....	.....	.....	.50	225.00	.55	247.50
Spikes (8 kegs)	.....	.....	.....	.....	4.87	38.96	4.60	36.80

Abstract of proposals for furnishing stone, sand, and cement at the Breakwater, Buffalo, N. Y.

[Opened at 12 o'clock meridian (eastern standard time) June 9, 1887, at the United States Engineer Office, Buffalo, N. Y., by Capt. F. A. Mahan, Corps of Engineers, under advertisement dated May 19, 1887.

Names and addresses of bidders.	Stone.				Cement.	Sand, 5,600 cubic yards.	Total amount of bid.
	First class, 160 cubic yards.	Second class, 610 cubic yards.	Third class, 460 cubic yards.	Fourth class, 7,800 cubic yards.	Dyckerhoff or White Bros., 2,450 bbls.		
1. William E Carroll, Buffalo, N. Y.	price	.....	.....	.....	.....	$1.05	.....
	total	.....	.....	.....	.....	5,880.00	$5,880.00
2. Williams & McConnell, Buffalo, N. Y.	price	$3.50	$7.50	$8.50	$1.84	*$2.52	.....
	total	560.00	4,575.00	3,910.00	14,352.00	6,174.00	29,571.00
3. Howard Fleming, New York, N. Y.	price	.....	.....	.....	.....	†2.09	.....
	total	.....	.....	.....	.....	5,120.50	5,120.50

*Hanover cement. †Gibbs's cement; $2.09 per barrel if admitted duty free.

Bids for stone of the first, second, and third classes were rejected.
Bids for sand was rejected.

COMMERCIAL STATISTICS.

Buffalo Harbor, New York, is situated within the collection district of Buffalo Creek, New York.

The harbor is lighted by—

(1) A fixed white light, known as the Buffalo light. It stands 125 yards from the outer end of the south pier at the entrance to Buffalo Creek. It is of the third order. It is 65 feet above the level of the lake and is visible at a distance of 14¼ miles. It is in latitude 42° 52′ 40″ north, and longitude 78° 53′ 24″ west.

(2) A fixed red light, known as the Buffalo breakwater light. It stands on a crib at the north end and on the land side of the main arm of the Buffalo breakwater. It is of the fourth order, 37 feet above the level of the lake, and visible at a distance of 12¼ miles. It is in latitude 42° 52′ (39″) north and longitude 78° 53′ 56″ west.

(3) A fixed white light varied with a white flash every ninety seconds, known as the Horseshoe Reef light. It stands on Horseshoe Reef, at the entrance to Niagara River. It is of the fourth order, 43 feet above the level of the lake, and visible at a distance of 12¼ miles. It is in latitude 42° 52′ 53″ north, and longitude 78° 54′ 56″ west.

Fort Porter is within the city limits on Niagara River.

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TABLE I.—*Receipt of timber products by lake during the year ending December* 31, 1886.

		1884.	1885.	1886.
Headings	barrels	.....	65,000	75,000
Hoops	number	350,000	550,000	424,000
Lumber	feet	231,653,000	240,637,000	279,493,000
Lath	pieces	13,099,000	18,185,000	12,168,500
Railroad ties	number	100,000	87,500	54,780
Staves	do	1,119,560	2,028,130	1,289,560
Stave bolts	cords	6,948	9,889	9,710
Shingles	number	37,616,000	52,716,000	58,582,000
Shooks	bales	84,690	3,260	.....
Posts	number	60,000	300,000	255,000
Logs	feet	28,000,000	35,000,000	13,650,000

TABLE II.—*General imports by lake during year ending December* 31, 1886, *compared with those during year ending December* 31, 1885.

Articles.		Quantity.	Increase over 1885.	Decrease under 1885.
Grain	tons	2,675,269	953,548	.....
Oil cake	packages	229,960	105,520	.....
Lard	do	193,810	140,030	.....
Feed	sacks	387,170	181,780	.....
Pork	barrels	31,450	24,400	.....
Lead	pigs	106,740	30,210	.....
Lead	tons	90	90	.....
Seed (other than flax)	bags	71,500	30,760	.....
Flaxseed	tons	58,805	.....	26,942
Coal	do	520	.....	.....
Copper	do	24,878	5,680	.....
Copper	bars	35,663	34,583	.....
Copper	packages	834	.....	551
Copper ore	tons	660	660	.....
Iron ore	do	21,534	14,374	.....
Pig iron	do	18,376	5,660	.....

TABLE III.—*Imports by lake during year ending December* 31, 1886, *other than those mentioned in Tables I and II.*

Articles.		Quantity.	Articles.		Quantity.
Alcohol	barrels	393	Leather	rolls	110
Ashes	casks	337	Oil	barrels	4,797
Bacon	tierces	305	Peas	bushels	34,806
Beans	bushels	1,700	Pelts	bundles	964
Bullion	bars	880	Rags	sacks	3,091
Corn meal	barrels	3,188	Silver ore	do	38,277
Cotton	bales	1,786	Silver ore	tons	909
Fish	packages	25,083	Spelter	plates	41,752
Glucose	barrels	11,343	Starch	boxes	10,821
Grease	tierces	5,709	Stearine	barrels	797
Hair	barrels	69	Sugar	do	375
Hay	tons	218	Tallow	do	8,046
Hides	bundles	1,024	Tobacco	packages	10,416
Malt	bushels	19,042	Wood	cords	785
Meal	sacks	114,954	Wool	bales	10,786
Oatmeal	barrels	5,414	Zinc	casks	106

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TABLE IV.—*Relative amounts of grain delivered in New York City by various routes during the year ending December* 31, 1886.

Route.	Bushels of grain by each route.	Per cent. by each route.
Canal	44, 036, 522	32. 64
New York Central and Hudson River	27, 372, 525	20. 91
New York, Lake Erie, and Western Railway	20, 669, 936	15. 79
Delaware, Lackawanna, and Western Railway	10, 221, 678	7. 81
Pennsylvania Railroad	10, 049, 575	7. 67
New York, West Shore and Buffalo Railway	10, 006, 272	7. 64
By river and coastwise	2, 132, 370	1. 63
By various routes not mentioned above	6, 421, 184	4. 91
Total	130, 910, 062	100. 00

Arrivals and departures of vessels during the year ending December 31, 1886.

	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steamers	1, 424	1, 537, 183	1, 505	1, 603, 575
Sailing vessels	2, 228	793, 727	2, 192	753, 036
Total	3, 652	2, 330, 910	3, 697	2, 356, 611

Amount of revenue collected during the year ending December 31, 1886. $965, 819. 61
Value of imports, same year 6, 174, 651. 00
Value of exports, same year 420, 268. 00

The commercial statistics for Black Rock Harbor are included with those for Buffalo Harbor.

REPAIRS TO LAKE HARBOR WORKS.

OFFICE OF THE CHIEF OF ENGINEERS, U. S. ARMY,
Washington, D. C., November 5, 1886.

SIR: The accompanying communications of October 29 and 30 to this office, from Capt. F. A. Mahan, Corps of Engineers, submitting estimates for repairs to the breakwater and other structures at Buffalo, which he reports as absolutely necessary to enable the works to be tided over the coming winter, are referred to the Board of Engineers for consideration and report as to the present necessity or expediency of such repairs.

The Board will detail one or two of its members to make a personal examination of the works at Buffalo, with the view to a better understanding of their condition. In connection with this special duty the Board, at its convenience, will take into consideration and report upon the general subject of future repairs to Lake Harbor works, the costs of which, as will be seen from the annual reports of this office, are augmenting to such a degree, owing to the perishable nature of the material used in construction and the increase of cost of that material, as to call for serious consideration whether the use of timber shall be continued or some other mode of repair or construction adopted for the future.

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It is desired that the report first requested be made at as early a day as practicable.

By command of Brigadier-General Duane.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Colonel of Engineers, Bvt. Maj. Gen., U. S. A.

Col. THOMAS LINCOLN CASEY,
Corps of Engineers, President Board of Engineers for Fortifications and for River and Harbor Improvements.

FIRST REPORT OF THE BOARD OF ENGINEERS.

OFFICE OF BOARD OF ENGINEERS FOR FORTIFICATIONS AND FOR RIVER AND HARBOR IMPROVEMENTS, ETC.
New York, December 16, 1886.

GENERAL: Referring to the communicaton from Captain Mahan, reporting injuries to the breakwater at Buffalo during the gale of October 14, referred to the Board by your letter of November 5, I have to report that a committee, consisting of Colonels Abbot and McFarland, have visited the locality and personally examined the breakwater.

Very extensive repairs to the older portion at the northern end will be necessary next year, but at present they are impracticable from the lateness of the season. Work must be restricted to measures to secure the cribs from further injuries, and especially from further loss of stone by waves breaking over the structure. The old sea-wall, now broken down in places and rendered unnecessary by the extension of the breakwater, contains a supply of stones varying in weight from 1,600 to 3,200 pounds, which Captain Mahan estimates may be placed upon the small stone in the broken cribs for about $2 per cubic yard, forming a sort of rough protective flagging. There are about 600 square yards of surface thus exposed. Hence a covering one cubic yard in depth will cost about $1,500.

While the Board regard this as a somewhat doubtful expedient, it offers enough chances of preventing the loss of small stone during the winter to justify the outlay. It may be found expedient to raise slightly the level of the lowest part of some of the broken cribs by a layer of new timber, and care should be taken to bed the heavy stone in such a manner as to secure the greatest possible stability.

Work should begin at the extreme northern end near the light-house, where the worst injury occurred. As captain Mahan estimates that about 40 yards can be placed daily on the cribs, 600 yards can be placed in about three weeks.

It is believed that from $1,500 to $2,500 can be judiciously expended at once in the mode recommended.

On behalf of the Board:

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Colonel of Engineers,
President of the Board.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

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SECOND REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, February 2, 1887.

GENERAL: The Board of Engineers has the honor to submit the following report on the general subject of future repairs to lake harbor works, in compliance with your letter of November 5, 1886, referring to breakwater at Buffalo, N. Y.

The method of constructing piers and breakwaters for harbor improvements on the Great Lakes by means of large cribs of timber filled with small rubble-stone was originally adopted by reason of its economy and the indefinite durability of timber in fresh water. The superstructure, or portion of the works above-water has been built in the same manner, but it was contemplated that it should be ultimately replaced by masonry.

The Board of Engineers on Erie Harbor (1853), of which Lieutenant Colonel James Kearney, Topographical Engineers, was president, laid down certain rules for the construction of crib-piers and breakwaters. Among other things the Board states:

"That due time having been allowed for the ultimate settlement of the structure, the upper part of it should be replaced by masonry, namely, from a point so low that the timber of the foundation may not be liable to come in contact with the atmosphere."

The average duration of timber above water is about fifteen years, and it has been found more economical to renew the timber from time to time than to resort to masonry. The increasing scarcity and cost of timber, and the continual expense of repairs made necessary by storms and collisions, renders it important that these works should be made more permanent. The superstructure should be replaced by masonry where the substructure will admit of it.

The character of the masonry will depend on the location and exposure of the works. In 1875–'78, the timber superstructure of the north pier of Milwaukee Harbor, built in 1855–'57, for a distance of 1,130 feet from the shore, was replaced by dry-stone masonry. This pier is 20 feet wide, and the substructure consists of cribs of 12-inch by 12-inch timber, each 32 feet in length. The side and cross-walls of the cribs are built solid, and were designed to afford the necessary support to the masonry superstructure. The old superstructure was removed and the timber taken off for a distance of about 2 feet below the mean lake level, where the timber was found sound.

The platform of 12-inch by 12-inch oak timber, each 32 feet long and 4 feet wide, were placed lengthwise of the crib, resting on the side and cross-walls. These platforms support two walls of large stone, each 4 feet thick. The space between the walls is filled with dry rubble taken from the old work, covered with rough paving stone about one foot thick. The stone for the walls and pavements are quarry face and laid without mortar. The stone is a limestone, from a quarry at Milwaukee; a section of the pavement was made of concrete 9 inches thick as an experiment; the cement used was American Portland cement. As to the present condition of the work, Mr. W. H. Hearding, assistant engineer, in a letter dated December 7, 1886, states as follows:

"There are a few of the top stones (particularly the paving between walls) cracked, but not to such an extent as to require immediate renewal or in any way condemn the method of constructing the superstructure with stone. The work 'in toto' may be said to be as efficient

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as when first constructed. The concrete has not stood as well as it might have done with more experience and slightly different treatment."

The average cost of the work was $36.52 per running foot of pier.

A cross-section of this superstructure is given in Report of the Chief of Engineers for 1878, page 1166.

It is believed that a superstructure similar to this, if built of durable stone, will answer the requirements for piers extending from the shore out to a depth of 12 feet, more or less, depending on the exposure.

For the portion of the piers in greater depth and for detached breakwaters a different kind of masonry is required.

There are few examples of such work in this country, but the recent experience abroad seems to favor the use of concrete in large masses. The cross-section of breakwaters now generally adopted abroad consists of a wall of concrete, vertical, or nearly so, resting on the natural bottom, where the depth is not too great, or upon a base of rubble, the top of which should be at a distance below water, where the stone will not be disturbed by wave action. This distance is variable, but with improved methods vertical walls have been built economically on rubble foundations 22 feet below water, and this could be exceeded if necessary.

In some cases, where the bottom is favorable, the foundation is made of concrete in large bags holding from 5 tons upward; in a few instances as much as 100 tons.

Examples of these are given in "Harbours and Docks," by Harcourt.

The project now being carried out for closing the opening between the Delaware Breakwater and the ice-breaker, 1,390 feet long, consists of a foundation of stone, irregular in size, the top of which is 48 feet wide, 12 feet below low water, surmounted by a wall of concrete 24 feet wide at the base, 24 feet high, and 12 feet wide at top; the concrete to be built in large masses with the above cross-section, and each mass 16 feet long. This work is greatly exposed to storms and the action of fields of ice.

In our crib-piers and breakwaters we have vertical walls from the bed of the lake or from foundations of rubble-stone at a distance of several feet below the surface.

For exposed localities, such as the outer portions of piers and breakwaters, it is considered that the use of concrete in large masses either with or without a facing of masonry, as may be determined by the work recommended by the Board for the superstructure of the Buffalo Break-water, offers the most satisfactory solution generally for replacing the superstructure of existing works. The timber superstructure should be cut down to afford a good foundation and leave no timber exposed to the air. The cross-section of the superstructure will depend on the exposure and will vary very much. Some of our crib breakwaters are as wide as from 30 to 40 feet. It is not necessary in such cases that the concrete superstructure should have the full width.

There will doubtless be found many cases where a good foundation can not be had owing to imperfect construction or irregular alignment and settlement of the cribs; and it may be necessary to build an independent substructure. In this connection it would be well to consider the advisability, in future work, of constructing the substructure of concrete or other masonry. Although timber will last indefinitely in fresh water, the cribs are exposed to injury from collisions and storms for several feet below water, making repairs difficult and expensive. A work entirely of masonry would be permanent and the repairs reduced to a minimum.

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The substitution of masonry for timber cribs is largely a question of cost.

There are a number of pile-piers on the lakes, located generally at the mouths of streams, consisting of two rows of piles cut off at or below the water-surface, surmounted by a timber superstructure, and filled with brush or slats loaded with stone. These were adopted as being less costly than cribs; they are quite narrow and do not extend to great depths of water. Should it ever be found advisable to replace the superstructure by masonry, it can be supported on a platform of timber placed below water and resting on the piles.

While indicating concrete in large masses as the best material generally for the construction of the superstructure on account of economy and the resistance it will afford to the action of storms, there are, doubtless, cases where other methods may be adopted, such as ordinary stone masonry or large blocks of stone with quarry face, laid without mortar.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers.
HENRY L. ABBOTT,
Colonel Engineers, Bvt. Brig. Gen.
C. B. COMSTOCK,
Lieut. Col. of Engineers and Bvt. Brig. Gen.
D. C. HOUSTON,
Lieut. Col. Engineers, Bvt. Colonel.

Brig. Gen. JAMES C. DUANE,
Chief of Engineers, U. S. A.

EXTRACT FROM INDORSEMENT OF THE BOARD OF ENGINEERS ON LETTER OF CAPTAIN MAHAN OF DECEMBER 15, 1886, SUBMITTING PROJECT FOR THE RECONSTRUCTION OF THE BREAKWATER AT BUFFALO, NEW YORK.

THE BOARD OF ENGINEERS,
New York, February 2, 1887.

* * * * * * *

Referring to the Buffalo Breakwater, the Board recommends that the superstructure for a distance of 500 feet from the northern end be constructed of concrete faced with rough stone masonry, having a cross-section as shown on the accompanying tracing marked No. 1, and that the next 500 feet be entirely of concrete as shown on tracing No. 2. Access to the top of the work is to be afforded by flights of stone steps 500 feet apart.

This locality affords a favorable opportunity for testing these methods of construction.

The concrete on the face and top of the work for a thickness of about 3 feet should be made with rich Portland cement mortar. The superstructure should have points at right angles to the line of the breakwater over the junctions of the cribs.

The work proposed will about exhaust the funds now available, and the experience gained will be valuable in considering projects for its extension.

On behalf of the Board.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers,
President of the Board.

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Recommended for approval by the Chief of Engineers except as to that of plan of No. 2, the extent of which should be reduced from a distance of 500 feet to that of 250 feet.

Approved by the Secretary of War February 17, 1887.

M M 4.

IMPROVEMENT OF NIAGARA RIVER, NEW YORK.

No work was done during the year. Available funds will be held for such further improvement of the channel as may be practicable.

Name of harbor, Tonawanda, N. Y.; collection districts, Buffalo Creek and Suspension Bridge.

Money statement.

July 1, 1886, amount available	$587 52
July 1, 1887, amount available	587.52

COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1886.

Class.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	346	110,979	343	108,065
Sailing vessels	813	285,087	800	278,271
Total	1,159	396,066	1,143	386,336

Amount of revenue collected during year ending December 31, 1886	$58,183.05
Value of imports same year	614,751.00
Value of exports same year	14,000.00

Greatest draught of vessels, 13½ feet.

M M 5.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

I relieved Capt. C. F. Palfrey, Corps of Engineers, of the charge of this work on September 30, 1886, in compliance with Special Orders No. 188, paragraph 15, dated Headquarters Assistant Adjutant-General's Office, August 14, 1886.

No work was done during the fiscal year. The depth of the channel between the piers is about 8 feet. The shore to the eastward of the east pier is in process of being gradually undermined, and it is but a question of time until a break is made through to Twelve Mile Creek.

The piers are both in great need of repairs. Contracts have been made for the materials required as follows:

On June 23, 1886, with G. Elias & Bro., for timber.

On June 11, 1886, with Miles S. Vosburgh, for stone.

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An informal contract with D. McNaughton, for iron.
These awards were in accordance with proposals opened May 16, 1887.
It is proposed for the coming year to repair the cribs.

Name of harbor, Wilson, N. Y.; collection district, Niagara, N. Y.; nearest work of defense, Fort Niagara, N. Y.; nearest light-house, Olcott, N. Y.

Money statement.

July 1, 1886, amount available		$32.29
Amount appropriated by act approved August 5, 1886		10,000.00
		10,032.29
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$630.66	
July 1, 1887, outstanding liabilities	1,117.80	
		1,748.46
July 1, 1887, amount available		8,283.83
Amount (estimated) required for completion of existing project		50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing timber, iron, and stone at Wilson Harbor, N. Y., opened at 12 m. on May 16, 1887.

No.	Names and addresses of bidders.	White pine (22,488 ft., B. M.)		Drift-bolts (2,200 pounds).		Spikes (3 kegs).		Stone (285 cubic yards).	
		Per M. feet.	Total.	Per pound.	Total.	Per keg.	Total.	Per cubic yard.	Total.
				Cents.					
1	Lavcock Lumber Company, Buffalo, N. Y	$25.00	$562.20	.....	.....	.....	.....	.....	.....
2	G. Elias & Bro., Buffalo, N. Y	23.50	528.47	.....	.....	.....	.....	.....	.....
3	Beals & Brown, Buffalo, N. Y	.....	.....	3.4	74.80	$5.25	15.75	.....	.....
4	Daniel McNaughton, Buffalo, N. Y	.....	.....	2.9	63.80	4.80	14.40	.....	.....
5	Miles S. Vosburgh, Wilson, N. Y	.....	.....	.....	.....	.....	.....	$1.21	344.85
6	Owen & Calvert, Youngstown, N. Y	.....	.....	.....	.....	.....	.....	1.40	399.00

COMMERCIAL STATISTICS.

Arrival and departures of vessels during the year ending December 31, 1886.

Class.	Entered.			Cleared.		
	Number.	Tonnage.	Average.	Number.	Tonnage.	Average.
Sailing-vessels	1	106	106	2	265	132

Amount of revenue collected during the year ending December 31, 1886, $1.25; value of imports same year, $5. Greatest draught of vessels, 9 feet.

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M M 6.

IMPROVEMENT OF OLCOTT HARBOR, NEW YORK.

I relieved Capt. C. F. Palfrey, Corps of Engineers, of the charge of this work on September 30, 1886, in accordance with Special Orders No. 188, paragraph 15, dated Headquarters Assistant Adjutant-General's Office, August 14, 1886.

No work was done during the last fiscal year.

The piers are very much dilapidated and in urgent need of repairs. Contracts have been made for the necessary materials, and work will be begun so soon as they shall have been received. The contracts were made as follows:

On June 29, with Miles S. Vosburgh for timber.

On June 29, with Miles S. Vosburgh for stone.

An informal contract was made with D. McNaughton for the iron.

Name of harbor, Olcott, N. Y.; collection district, Niagara, N. Y.; nearest work of defense, Fort Niagara, N. Y.; nearest light-house, Olcott, N. Y.

The Olcott Light is on the outer end of the west pier, at the entrance to Olcott Harbor, mouth of Eighteen Mile Creek. It is a fixed white light, of the sixth order, 32 feet above the level of the lake, and visible from a distance of 11½ miles. Its position is latitude 43° 20′ 27″ N., and longitude 78° 43′ 18″ W.

Money statement.

Amount appropriated by act approved August 5, 1886		$10,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$634.74	
July 1, 1887, outstanding liabilities	4,278.96	
		4,913.70
July 1, 1887, amount available		5,086.30
Amount (estimated) required for completion of existing project		30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of proposals for furnishing timber, iron, and stone at Olcott Harbor, N. Y., opened at 12 m. on May 16, 1887.

No.	Names and addresses of bidders.	White pine (131,768 ft., B. M.).		Drift-bolts (9,700 pounds).		Spikes (10 kegs).		Stone (474 cubic yards).	
		Per M feet.	Total.	Per pound.	Total.	Per keg.	Total.	Per cubic yard.	Total.
				Cents.					
1	Laycock Lumber Company, Buffalo, N. Y.	$25.00	$3,294.20	.....	.....	.....	.....	.....	.....
2	G. Elias & Bro., Buffalo, N. Y.	25.00	3,294.20	.....	.....	.....	.....	.....	.....
3	Beals & Brown, Buffalo, N. Y	.....	.....	3.4	$329.80	$5.25	$52.50	.....	.....
4	Daniel McNaughton, Buffalo, N. Y	.....	.....	2.9	281.30	4.80	48.00	.....	.....
5	Miles S. Vosburgh, Wilson, N. Y	24.90	3,281.02	.....	.....	.....	.....	$1.22	$578.28
6	Owen & Calvert, Youngstown, N. Y	.....	.....	.....	.....	.....	.....	1.55	734.70

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COMMERCIAL STATISTICS.

Arrivals and departures of vessels during the year ending December 31, 1886.

Class.	Arrivals.			Departures.		
	Number.	Tonnage.	Mean.	Number.	Tonnage.	Mean.
Steamers	6	1,435	239	6	1,435	239
Sailing-vessels	12	146	12	12	146	12
Total	18	1,581	.....	18	1,581	.....

Amount of revenue collected during the year ending December 31, 1886.... $17.00
Value of imports same year 500.00
Value of exports same year 1,929.00
Greatest draught of vessels, 8 feet.

M M 7.

IMPROVEMENT OF OAK ORCHARD HARBOR, NEW YORK.

I relieved Capt. C. F. Palfrey, Corps of Engineers, of the charge of this work on September 30, 1886, in compliance with Paragraph 15, Special Orders No. 188, dated Headquarters Assistant Adjutant-General's Office, Washington, D. C., August 14, 1886.

No work was done during the fiscal year. The breach between the east pier and the shore was not widened. The superstructure of the east pier is very badly decayed. The west pier is in good condition.

Contracts for furnishing timber, iron, and stone for the repairs of the east pier have been made as follows:

On January 11, with Miles S. Vosburgh for timber.
On June 17, with Daniel McNaughton for iron.
On June 21, with Hannibel S. Selhiemer for stone.

During the coming season it is proposed to rebuild as much of the superstructure of the east pier as the appropriation will allow.

Name of harbor, Oak Orchard; collection district, Genesee, N. Y.; nearest work of defense, Fort Niagara, N. Y.; nearest light-house, Oak Orchard, N. Y.

The Oak Orchard light is on the outer end of the west pier at the entrance to Oak Orchard. It is a fixed white light of the fourth order. It stands 31 feet above the level of the lake, and is visible at a distance of 11½ miles. Its position is latitude 43° 22′ 29″ north, and longitude 78° 11′ 40″ west.

Money statement.

July 1, 1886, amount available		$94.81
Amount appropriated by act approved August 5, 1886		12,500.00
		12,594.81
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$735.99	
July 1, 1887, outstanding liabilities	8,645.59	
		9,381.58
July 1, 1887, amount available		3,213.23
Amount (estimated) required for completion of existing project		92,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

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Abstract of proposals for furnishing timber, iron, and stone at Oak Orchard Harbor, New York.

[Opened on May 16, 1887, at 12 m., at the United States Engineer Office, Buffalo, N. Y.]

Names and addresses of bidders.	White pine, 274,566 feet, B. M.		Drift-bolts, 1,700 pounds.		Spikes, 17 kegs.		Stone, 1,043 cubic yards.	
	Price.	Total.	Price.	Total.	Price.	Total.	Price.	Total.
1. Laycock Lumber Company, Buffalo, N. Y	$25.00	$6,864.00	Cents.					
2. G. Elias & Bro., Buffalo, N. Y	25.00	6,864.00						
3. Beals & Brown, Buffalo, N. Y			3.4	$5.78	$5.25	$89.25		
4. Daniel McNaughton, Buffalo, N. Y			2.9	4.93	4.80	81.60		
5. Miles S. Vosburgh, Wilson, N. Y.	24.90	6,836.54					1.25	$1,282.95
6. George M. Waterman, Albion, Orleans County, N. Y			3	5.10	5.50	93.50		
7. Owen & Culvert, Youngstown, N. Y							1.80	1,877.40
8. Hannibel S. Selhiemer, Carlton, Orleans County, N. Y							1.15	1,199.45

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1886: Arrivals, 5 sailing vessels, 552 tons, 110 tons average. Departures, 5 sailing vessels, 498 tons, 100 tons average.

Revenue collected during the year ending December 31, 1886 ..... $1,196.06
Value of imports, same year 8,431.00
Value of exports, same year 29.00

Greatest draught of vessels, 11 feet.

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APPENDIX NN.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO, EAST OF OAK ORCHARD, NEW YORK.

REPORT OF CAPTAIN CARL F. PALFREY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charlotte Harbor, New York.
2. Pultneyville Harbor, New York.
3. Great Sodus Harbor, New York.
4. Little Sodus Harbor, New York.
5. Oswego Harbor, New York.
6. Sackett's Harbor, New York.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 27, 1887.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1887, for the works of river and harbor improvements under my charge.

I have the honor to be, very respectfully, your obedient servant,

CARL F. PALFREY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

NN 1.

IMPROVEMENT OF CHARLOTTE HARBOR, NEW YORK.

OBJECT.

To secure a navigable channel at the mouth of the Genesee River, on Lake Ontario.

PROJECT.

The original project, adopted in 1829, and executed between that date and 1834, was to obtain a channel 480 feet wide and 12 feet deep, formed and protected by parallel piers extending to deep water of the lake.

The present project, adopted 1881, is to secure and maintain, by pier extension and dredging, a channel of navigable width and 15 feet depth at extreme low water.

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No dredging has heretofore been done, the channel having been formed and kept open by the current of the Genesee River.

PRESENT WORKS.

(1) *West pier*, 3,173 feet of crib-work, being 230 feet; 10 feet wide, 805 feet with substructure 20 feet wide and superstructure 10 feet wide; cribs built prior to 1834; 10 foot superstructure, built 1864, decayed to water-level; then 1,835 feet 20 feet wide; cribs built in 1829–'34; superstructure rebuilt in 1864–'72, in need of renewal; (this includes the old pier-head); 303 feet 20 feet wide, built in 1883–'84, in good condition.

(2) *East pier*, 3,323 feet of crib-work, being 420 feet cribs, 20 feet wide, built in 1829–'34, and superstructure not renewed since that time; now under water; then 646 feet of cribs 20 feet wide, with superstructure of same width; cribs built in 1828–'34, and superstructure renewed in 1864–'67; then 800 feet cribs 20 feet wide, built in 1828–'34, with superstructure 20 feet wide, renewed in 1886.

Then 1,004 feet of cribs 20 feet wide, built in 1828–'34, with superstructure renewed 1868–'70.

Then 303 feet cribs and superstructure 20 feet wide, all built in 1883–'84.

Then 150½ feet cribs and superstructure 20 feet wide, built in 1884–'85.

All the superstructure needs renewal except those parts above described as built since 1883.

CHANNEL.

The present channel has a least width of 150 feet, with 13 feet depth at zero of gauge.

OPERATIONS.

The rebuilding of 800 linear feet of superstructure of east pier near present shore-line, wrecked by storm in spring of 1886. This work was carried on subject to interruption by storm and ice. Owing to difficulty in obtaining stone, much of that used in filling the new work was taken from the dilapidated portions of the pier, well inside the present shore-line. The work was done by hired labor, and materials purchased in open market after advertisement by circular.

Operations closed December 22, 1886; they will be resumed when the stage of water permits. The present stage is 2½ feet above the level at which work must begin.

Gauge-readings of water-level have been kept up at Charlotte three times daily during the year.

REMARKS.

At this port, since the commencement of work in 1829, the shore-line has advanced against the west pier about 1,100 feet, against the east pier about 700. The land so formed on the west side has been improved and cultivated by the Ontario Beach Improvement Company, who have rebuilt along their river front the superstructure of about 500 feet of the old pier. Of the land formed on the east side, a plat was given to the United States Life-Saving Service for their station, and they are now rebuilding superstructure on their river front, as well as protecting their lake front against encroachment by waves. The portions of the old pier so occupied, and those inshore therefrom, are no longer essential to the harbor works.

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In estimating repairs required, I have therefore included only the portions lakeward from the new work mentioned.

The old guide-piles (303) along the channel-face of the piers, now decayed and broken to a little below water-level, have become a serious damage. Unless the water-level should be higher than usual during this season, it will be necessary to do a considerable amount of dredging outside the entrance. The larger coal steamers were barely floated at the close of last season.

By its position on the lake, near the middle of the south shore, Charlotte has greater advantage, in length of haul, over the railroad lines which pass around the lake than any other port. As the lake-port of Rochester (which city is the seat of all its business) it has also a wider railroad connection than any other port. It is also the only port having a direct communication with the principal mining regions of bituminous coal, and making large shipments of that product (a small quantity is shipped from Great Sodus). The trade in this article extends as far east as Montreal.

From its railroad advantages, its favorable position on the lake as regards length of run in doubtful weather, and its present control of bituminous coal shipments, I consider Charlotte to have the best prospects of all the American ports on Lake Ontario, and the completion and maintenance of its harbor works to promise material benefit to commerce.

I cannot but regard the comparative statistics, presented as required, as misleading. The tonnage of 1881 was exceptionally large. A full examination of the statistics of ten years past shows a general increase, which is also observable 1882–'87.

RECOMMENDATIONS.

At this harbor I have the honor to recommend:

(1) Maintenance of existing piers, lake sections, as above described.

(2) Removal of decayed guide-piles.

(3) Dredging to 15 feet at extreme low water, both between piers and across outer bar.

ESTIMATES.

For repairs	$30,000
For removal of guide-piles	1,500
For dredging	25,000
Contingencies, 20 per cent	11,300
	67,800

Name of harbor, Charlotte, N. Y. Collection district, Genesee, N. Y. Nearest lighthouse, Genesee, N. Y. (at Charlotte), a fixed red light of the fourth order on crib, 300 feet inside of outer end of west pier. Forts Niagara and Ontario, N. Y., are the nearest works of defense.

Money statement.

July 1, 1886, amount available		$2,605.48
Amount appropriated by act approved August 5, 1886		26,250.00
		28,855.48
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$7,948.50	
July 1, 1887, outstanding liabilities	167.60	
		8,116.10
July 1, 1887, amount available		20,739.38

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Amount (estimated) required for completion of existing project $72,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1889 67,800.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

The amount of commerce and navigation when the work of improvement began under the present project in 1881.

	Number.	Tonnage.
Arrivals	652	149,[illegible]
Departures	646	146,[illegible]

Imports	$499,798.00
Revenue collected, 1881	80,450.61

Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	254	64,404	265	65,[illegible]
Sailing vessels	364	84,493	420	93,[illegible]
Total	618	148,897	685	159,[illegible]

Revenue from customs for fiscal year ending June 30, 1887	$72,[illegible]
Value of imports, same year	451,517.00
Value of exports, same year	620,926.00

Greatest draught of vessels, about 12 feet.

N N 2.

IMPROVEMENT OF PULTNEYVILLE HARBOR, NEW YORK.

OBJECT.

To furnish a protected channel of navigable width and not less than 10 feet depth at the mouth of Salmon Creek, Wayne County, N. Y.

PROJECT.

The present project provides for a breakwater running easterly from the west shore; a west pier thence northerly into the lake; an east pier parallel to it and 200 feet eastward.

Also a dredged channel between the piers, behind the breakwater, and 400 feet up the creek.

It was proposed in 1884, in order to make dredging of any permanent effect, to build a sand-tight pier parallel to the breakwater and 100 feet southerly from it.

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PRESENT WORKS (ALL IN FAIR CONDITION).

(1) *The west breakwater*, 330 feet of crib-work, being 50 feet from the shore eastward, 15 feet wide, built at local expense prior to 1867; superstructure repaired by the United States in 1871; and 180 feet to the angle, 20 feet wide, built in 1871.

(2) *West pier*, 557 feet of crib-work 20 feet wide, with superstructure 4 feet high; being built 222 feet from angle in 1874 and 1875; then 93½ feet in 1880; 183 feet in 1882; 60 feet in 1883.

(3) *East pier*, 572 feet of crib-work, beginning 140 feet from shore, being 85.6 feet, 16 feet wide, built in 1880; 62 feet, 15 feet wide, built in 1877; 30 feet, 20 feet wide, built in 1877; 92 feet, 20 feet wide, built in 1873; 180 feet, 20 feet wide, built in 1872; 122 feet, 20 feet wide, built in 1873.

The earliest section of this pier was placed for greatest protection of channel already (1872) dredged; it was extended in both directions. The gap between it and shore was formerly occupied by a wharf, now removed.

CHANNEL.

Has a present depth of about 7 feet at extreme low water between the piers and near the angle of the breakwater, but at the creek mouth the depth is not more than 3 feet.

Operations, none.

REMARKS.

This port is now very nearly closed by the bar at the mouth of the creek. With the constant drift of a sandy beach, any work less than that of the full project of 1884 would be shortly obliterated.

The commerce to be benefited is that of a small neighborhood. The port has no rail or canal communication.

Name of harbor, Pultneyville, N. Y. Collection district, Genesee, N. Y. Nearest light-house, Big Sodus, N. Y. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1886, amount available	$2.90
July 1, 1887, amount available	2.90

COMMERCIAL STATISTICS.

The amount of commerce and navigation when the work of improvement began under the present project in 1870.

	Number.	Tonnage.
Arrivals	142	5,500
Departures	142	5,500

Revenue collected 1870, $1,068.75.

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Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

	Sailing vessels.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Arrivals	52	1,173	34	1,032
Departures	34	1,052	.....	.....

Revenue from customs for fiscal year ending June 30, 1887 ..... $531.26
Value of imports same year 3,849.00
Value of exports same year 1,032.00
The greatest draught of vessels, about 6 feet.

N N 3.

IMPROVEMENT OF GREAT SODUS HARBOR, NEW YORK.

OBJECT.

To secure a navigable channel from Lake Ontario to Great Sodus Bay, with depth of 15 feet.

PROJECT.

1828.—To contract the entrance of Great Sodus Bay to 470 feet by breakwaters extending from east and west shores, and to define and protect a channel 470 feet wide by piers extending to deep water in Lake Ontario.

1882.—To extend the piers to the 15-foot curve in the lake, and dredge the channel between them to 15 feet depth at extreme low water.

PRESENT WORKS.

(1) *West breakwater*, 2,160 feet; crib-work, 18 feet wide, built 1829–'34; first 1,953 feet covered by beach formed against it, 207 feet superstructure 10 feet wide rebuilt 1878.

(2) *West pier*, 1,568 feet of crib-work, being 961 feet 18 feet wide; cribs built in 1829–'34; rebuilt 1853–'54; superstructure renewed in 1878–'80, 423 feet 18 feet wide (including pier-head 40 feet wide); cribs built in 1829–'34, and rebuilt in 1867–'70; superstructure rebuilt in 1867–'70, 184 feet 20 feet wide; cribs and superstructure built in 1883.

(3) *East breakwater*, 1,647 feet crib-work, being shore-arm, 211 feet 14 feet wide, built 1884; 1,084 feet 14 feet wide, built 1829–'34; rebuilt, with superstructure, 1872–'74, 277 feet 14 feet wide, and 75 feet 18 feet wide, built 1829–'34; rebuilt 1853–'54, and again, with superstructure, 1875'76.

(4) *East pier*, 1,294 feet of crib-work, being 448 feet 18 feet wide, built 1829–'34; rebuilt 1853–'54; superstructure rebuilt 1875–'76, 492 feet 18 feet wide, built 1829–'34; rebuilt with present superstructure 1869–'70; 354 feet cribs and superstructure, 20 feet wide, built in 1883–'84.

CHANNEL.

A channel of about 12 feet depth at extreme low water and 50 feet wide, 30 feet off west pier, was dredged in November and December, 1886.

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The west half of the 470-foot channel had a depth of 8½ feet to 10 feet in 1886.

Only 200 feet of the width of channel has ever been dredged and the last half is shoal.

OPERATIONS.

To enable the piers to withstand the probable autumn and winter storms the deck was thoroughly repaired, its joists being replaced or re-enforced where necessary over 423 feet of the west pier, 70 feet of the east pier, and 15 feet of the east breakwater. This work was done by purchased material and hired labor.

Dredging, under contract with W. S. Malcolm, jr., was begun September 27, and continued till December 6, when the harbor was closed by ice. Thirteen thousand two hundred and twenty-four cubic yards were removed, giving a channel 15 feet in depth and 50 feet wide at time of work.

REMARKS.

(1) At this harbor the old superstructure of the piers is in good condition for its age, and with the repairs of last autumn has stood the winter well. Nine hundred and fifteen feet should, as a reasonable precaution, be completely renewed. The storms of last autumn showed a considerable leakage of sand through the old cribs of the west pier, built (1829–'34) of round timbers. The protection of the channel already dredged requires sheet-piling.

From the records, supplemented by the recollections of an assistant, I gather that dredging was not needed in this channel until the west pier was wrecked (between 1856 and 1868) and the channel filled in by the littoral drift. The dredging which has since been done has never been more than a narrow trench in a broad area of easily moved sand, and has been of little permanent value, as the amount removed has been very small in comparison with that remaining.

Were the whole entrance, 470 feet broad, once dredged to hard bottom, it is probable, as the ends of the piers are on hard bottom, that no more dredging would be required in many years, and that, with the broad entrance and fine roadstead in the bay, a valuable and permanent harbor of refuge would be secured.

The east breakwater needs renewal of superstructure through two-thirds of its length.

The amount now available barely suffices for minor repairs and for such dredging as will afford temporary relief to the immediate needs of commerce.

During the past two years the commerce of this port has markedly increased. The import of barley has risen from 117,624 bushels in 1883 and 1884 to 603,742 bushels in 1885 and 1886. None was imported previous to 1883, and the shipments of the last year were checked by shoal water, for which reasons I have made the comparison by two-year periods.

The export of coal has increased, though the late shipments were difficult because of shoal water.

During the calendar year there were shipped, of bituminous coal, 7,216 tons; of anthracite, 44,770 tons, of which about two-thirds went westward through the Welland Canal, mainly to American ports. Forty-one cars, containing 805 tons, were sent here for water shipment

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toward the close of the season, but were distributed by rail on account of the shoal water.

As the commerce of this port has increased during a period in which that of the two ports to the eastward of it has declined, and notwithstanding a local disadvantage from the condition of its channel, I conclude that it is less affected than they by the railroad combinations, and that an increase of commerce may be expected from the completion of the improvement.

No effect upon rates of freight or insurance, or upon competing lines of transportation, is distinctly traceable to the harbor works. In general, the conditions affecting Oswego have affected this harbor, though less disastrously.

RECOMMENDATION.

At this harbor I have the honor to recommend:

(1) Maintenance of the existing works.

(2) Dredging the entire space between the piers to hard bottom, and then, after, a channel 200 feet wide to 15 feet at extreme low water.

ESTIMATES.

For repairs	$27,500
For dredging	30,000
Contingencies, 20 per cent	11,500
	69,000

Name of harbor, Great Sodus, N. Y. Collection district, Oswego, N. Y. Nearest light-house, Big Sodus, N. Y.; a fixed white light of the fourth order, varied by a white flash every two minutes, on a bluff three-fifths mile west of entrance to bay. A fixed white light of the sixth order 180 feet inside of outer end of west pier, and a fixed red light of the sixth order at elbow of west pier. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1886, amount available		$1,639.44
Received of Capt. E. Maguire, Corps of Engineers, refundment		3.33
Amount appropriated by act approved August 5, 1886		16,875.00
		18,517.77
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,231.68	
July 1, 1887, outstanding liabilities	23.76	
		4,255.44
July 1, 1887, amount available		14,262.33
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		48,000.00

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COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under the present project in 1881.

	Number.	Tonnage.
Arrivals	53	5,937
Departures	78	7,788

Imports	$20,311.00
Exports	18,000.00
Revenue collected, 1881	3,238.67

Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	12	1,949	13	2,211
Sailing vessels	103	19,953	110	22,393
Total	115	21,902	123	24,604

Revenue from customs for fiscal year ending June 30, 1887	$32,603.93
Value of imports same year	177,699.00
Value of exports same year	74,697.00

Greatest draught of vessels, 11 feet.

N N 4.

IMPROVEMENT OF LITTLE SODUS HARBOR, NEW YORK.

OBJECT.

To secure a channel from Lake Ontario into Little Sodus Bay, of navigable width, and depth not less than 15 feet at low water.

PROJECT.

To contract by breakwaters the entrance of the bay to a width of 250 feet and maintain a channel 200 feet wide and 15 feet deep at extreme low-water level, protected by parallel piers.

PRESENT WORKS.

(1) *West breakwater*, 500 feet long, 10 feet wide, built 1870–'71, and decayed above mean water level.

(2) *West pier*, 1,956 feet of crib-work 20 feet wide, being 180 feet, built in 1854, and now without superstructure and below water; then 1,062 feet of cribs and superstructure built in 1867–'71, decayed above water (350 feet of this superstructure was raised 2 feet on channel side, new decked, and filled in 1878); 714 feet built in 1882–'83–'85, in good order.

(3) *East breakwater*, 1,855 feet, being 170 feet of brush fascine and stake dike, built 1885; 1,685 feet of crib-work 20 feet wide, built 1873–'78.

(4) *East pier*, 1,510 feet of crib-work 20 feet wide, being 512 feet, built in 1872–'73 and not since repaired, then 757 feet built in 1882, then 241 feet in 1883.

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CHANNEL.

The dredged channel has a width of 200 feet and a depth of 14 feet, at extreme low water, from the bay out to a point 700 feet inside the end of the west pier, beyond which is a shoal, with 12 to 14 feet depth, on which no dredging has ever been done.

OPERATIONS.

Office work only, the work being in condition fit to meet the winter, and the season too far advanced at the time money became available for renewal and rebuilding of superstructure.

Renewal and repairs of superstructure will be begun as soon as the stage of water permits. On June 30 the water was 2½ feet above the level at which work must begin.

REMARKS.

The works are in fair condition, needing minor repairs. The portion whose age calls for complete renewal is in fair condition for its age, and with as much renewal and repair as the amount available permits will probably last another winter.

The portion of the west breakwater not already buried by the beach formed against it will be protected by a brush and stone dike, of the construction which has proved successful at the shore end of the east breakwater at this port.

The shipments at this harbor during the past season have been in vessels of light draught plying to Canadian harbors. To enable shippers to utilize the capacity of the Welland Canal, as per present project, would call for a considerable amount of dredging.

The commerce of this port, which has for some time been declining under the influence of railroad competition for all traffic but that of the lake shores, has now a little prospect of revival from local railroads becoming part of the Lehigh Valley system.

RECOMMENDATION.

At this harbor I have the honor to recommend the maintenance of the existing works and channel.

ESTIMATES.

For repairs	$20,000
Contingencies, 20 per cent	4,000
	24,000

Name of harbor, Little Sodus, New York. Collection district, Oswego, N. Y. Nearest light-house, Fair Haven, N. Y., a fixed white light of the fourth order, near the head of the west pier. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1886, amount available		$2,418.28
Amount appropriated by act approved August 5, 1886		12,500.00
		14,918.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$722.70	
July 1, 1887, outstanding liabilities	2.50	
		725.20
July 1, 1887, amount available		14,193.08

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Amount (estimated) required for completion of existing project	$32,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	24,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under the present project in 1881.

	Number.	Tonnage.
Arrivals	151	17,913
Departures	247	30,058

Imports	$174,000.00
Exports	32,400.00
Revenues collected, 1881	34,223.82

Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	17	3,118	23	3,478
Sailing vessels	123	22,151	152	26,831
Total	140	25,269	175	30,309

Revenue from customs during the fiscal year ending June 30, 1887	$3,068.18
Value of imports same year	21,912.20
Value of exports same year	294,528.00

Greatest draught of vessels, 12 feet.

N N 5.

IMPROVEMENT OF OSWEGO HARBOR, NEW YORK.

OBJECT.

To provide a basin sufficient for the needs of commerce at the mouth of Oswego River, New York, and to secure and maintain a navigable channel into said basin and river.

PROJECT.

1827.—To inclose by breakwaters a western basin 11 acres outside bulkhead line, and an eastern basin 9 acres outside bulkhead line, and to protect the entrance channel by piers (Completed 1829); pier extended 1869.

1870.—To inclose by a breakwater, of crib-work filled with stone, a western basin of 100 acres outside 9-foot curve and existing western breakwater. (Completed 1882.)

1882. To build an eastern breakwater on alignment of western, sheltering an eastern, basin.

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1883.—To build spurs projecting from lake face of western breakwater, for the purpose of breaking the accumulated and reflex waves, occasioned by that breakwater, which have rendered the entrance exceptionally difficult and dangerous during storms.

PRESENT WORKS.

(1) *Inner west breakwater*, 1,429 feet, being a shore-arm, 250 feet, masonry; lake-arm, 110 feet; masonry, 977 feet; crib-work 30 feet wide, built 1828–'29; repaired and rebuilt, 1844–'54–'60–'67–'74; now ruinous from fire and decay. Light-house pier-head of irregular form, extending 92 feet on line of breakwater, lakeward 132 feet, built 1835; extension 432 feet of crib-work, 30 feet wide, built 1869.

The light-house pier-head and outer 838 feet of lake-arm were transferred to Light-House Department in 1886.

(2) *Inner east breakwater*, 750 feet, crib-work 30 feet wide, built 1828–'29, repaired 1844; transferred to Gerrit Smith, esq., in 1852.

The above work, excepting the extension of light-house pier-head, are not essential to the protection of the present harbor.

(3) *Outer west breakwater*, 6,032 feet; crib-work 35 feet wide, being shore-arm, 916 feet, built 1871–'72; superstructure rebuilt in parapet form on outer 76 feet in 1885; lake-arm, 2,910 feet, built 1872–'77; parapet superstructure, 1885, 1,460 feet, built 1877–'80, bearing original superstructure 8 feet high; 500 feet, built 1881–'82, with parapet superstructure built 1885; return 246 feet, built 1882, with parapet superstructure built 1885, on outer 70 feet.

The foundation of the inner 640 feet of the shore-arm is the natural rock bottom; that of the remaining 276 feet, and of the first 3,466 feet of the lake-arm, is the natural sand and gravel bottom; that of the remaining sand and gravel bottom; that of the remaining 1,650 feet is riprap deposited in a trench from 3 to 10 feet deep, dredged in sand.

In the lake-arm is a breach, 140 feet, made by storm in December, 1884. The broken ends of the parapet superstructure have been solidly bulkheaded. Their faces are at 465 and 605 feet from the angle. The cribs are destroyed to a depth of about 7 feet below extreme low water.

(4) *Detached spur*, 100 feet long, 40 feet wide, 250 feet from entrance, 10 feet from lake face of breakwater, on trenched riprap foundation, built in 1885.

(5) *East breakwater*, 248 feet; crib-work, 35 feet wide, being lake-arm, 213 feet, channel return 35 feet, with parapet superstructure, built 1882. Foundation, riprap in trench, dredged to bed-rock.

CHANNEL.

A channel 18 feet deep at entrance, shoaling to 15 feet in a little less than 2,000 yards, was dredged in 1884.

OPERATIONS.

As soon as funds were available work was begun on the strengthening of the lake face of parapet west breakwater by 5-foot screw-bolts (begun 1884), and also in neighborhood of breach and of spur-crib by steel bands lapping upon top course and extending to low-water level; also, of banquette harbor wall, where shaken by waves, by ties of iron. (Not yet completed.)

The shore-arm of same work, in need of complete renewal of super-

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structure, was repaired to meet the winter's storms, refilled with stone (40 cords), and 250 linear feet of deck replaced, mainly with old plank on hand. Expense, $673.69.

Minor repairs were also made on lake arm, principally of deck of banquette and of low superstructure.

Examination of the east breakwater showed deck and joists, for 90 feet at its eastern end, to be insecure, also a spreading open of the crib-work at southwest corner of work, extending to 17 feet below extreme low water. Much stone had also been lost from the pockets along the lake face of this work. A tight interior crib was sunk in the southwest pocket, and the 17 courses of timber, which had parted at the corner, were secured by steel plates wrapping the corner. The work was refilled and put in thorough repair. Expense, $1,773.46.

The wharves and mooring berth at shore end of old west breakwater, which were unsafe for the winter's use, were repaired. A small crib, washed ashore from the great breach of 1884, was towed to the western end of shore-line of United States reservation, outer west breakwater, grounded and filled with stone, as a protection to the beach, which had wasted rapidly during the past year. The derrick-scow was thoroughly repaired. Expense, $1,272.59.

A portion of parapet from breach of 1884, moored in the basin and a menace to shipping in case of storm, was broken up and its material used in repairs.

The above work was seriously interrupted by the autumn storms, and just as it neared completion a storm of exceptional violence, on November 19, did more damage than all those of the previous year. Two thousand square feet of deck with joist and cross-ties were crushed by weight of wave (no scar from below by any floating object appearing), 900 feet of harbor wall torn down 2 to 5 feet, 35 feet breach of banquette to 7 feet below water-level. In addition to the above the light-house pier was damaged by collisions of steamer *Baltic* and schooner *Belle Wilson*, and the northwest corner of east breakwater seriously by collision of schooner *Hoboken*. The spur-crib was undermined by the scour and settled along the western face.

The breach in the banquette was filled to water-level by a crib 32 feet by 10 feet by 7 feet, the walls and deck repaired, and the riprap along west face of spur-crib renewed; expense, $2,883.13.

The late operations were difficult because of the formation of ice on the timbers immediately after the storm. A steam jet from the boiler of the derrick-scow was used to clear the way for the working party.

Operations closed on December 16. All were by hired labor with material purchased or on hand. Bids have been received, and lowest bid accepted subject to approval, for the renewal and rebuilding of 840 feet of superstructure on shore arm of west breakwater, and operations will be begun as soon as the stage of water permits.

REMARKS.

With the renewal of the superstructure on shore-arm of outer west breakwater and minor repairs at various points, for which the amount now available "for repairs" will suffice, the works as standing for two fiscal years past will be in good condition.

The repair of the breach of December, 1884, which would involve removal of wrecked crib-work to lake bottom, replacing by heavier cribs, and rebuilding a considerable section of parapet on each side of the breach, has been estimated by my predecessors at $80,000. From this

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repair would result the complete protection of 2,000 feet of harbor front which was covered from 1874 to 1884, and which is now sufficiently exposed to injure its value for wharf building, On this reach of harbor front there were built, during the ten years in which it was fully protected from the westerly storms, three wharves, of which one is now occupied, one lately vacated, and one grass-grown.

The spur-crib, placed 1885, has proved a manifest improvement of the entrance to the harbor by its effect in breaking the accumulated wave sweeping the length of the lake front of the west breakwater. The completion of the project of 1883, by placing at least one more on that face, would materially aid this improvement, and also lessen the shock upon the one now placed, and the same upon its foundation, to which the latter has proved barely equal.

The amount available "for continuing the improvement" has, with the approval of the Chief of Engineers, been reserved to be applied to this work when a sufficient amount shall be available. The estimated cost of one spur-crib is $30,000.

A petition has been presented for the removal of the small section of east breakwater now completed, as offering greater hinderance to commerce by the increased difficulty of the entrance than aid by the additional harbor shelter afforded. My report upon this petition, presented in accordance with instructions from Chief of Engineers, is hereto appended. Estimated cost of removal, $15,000.

The present and prospective commerce of Oswego is discussed in that report; the returns of the two months of navigation since its rendition do not affect its statements.

When the present work was projected, and until 1874, the competing lines of transportation were:

(1) For the upper lakes. The Erie Canal as against the water-route by Lake Ontario and the Welland Canal, and the railroad lines westward, as against all water-routes.

(2) For Lake Ontario ports. None.

At the present time the freights first referred to are almost or quite diverted from Oswego by the competition among themselves of the other competitors.

For the carrying trade of the Ontario Basin there is now the competition of the railroad systems (embracing Canadian roads) which pass around the lake by bridge at Niagara, and by ferry at Morristown, Brockville, thus opening a winter route for a traffic (formerly) confined to the navigation season on the lake. For two years past this competition has been felt to the detriment of the commerce of Oswego, in each of its three principal lines, coal, lumber, and barley; in the first two shipments have diminished; the last holds nearly up to the average of the last nine years.

The general effect of the commercial rivalry as above has obliterated that of the harbor improvement.

RECOMMENDATION.

At this harbor I have the honor to recommend—

(1) The maintenance of the existing west breakwaters as now standing.

(2) The removal of the east breakwater.

(3) The building of one spur-crib 150 feet in length as per project of Major McFarland, 1883.

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ESTIMATES.

For repairs	$45,000
For spur	30,000
For removal of east breakwater	15,000
Contingencies, 20 per cent	18,000
	108,000

Name of harbor, Oswego, N. Y.; collection district, Oswego, N. Y.

Nearest light-house, Oswego, N. Y. A fixed white light of the third order at the eastern end of the old west breakwater, a fixed red light of the fourth order on eastern end of outer west breakwater, a fog-bell attached.

Money statement.

July 1, 1886, amount available			$114.67
Amount appropriated by act approved August 5, 1886			71,250.00
			71,364.67
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886		$8,130.14	
July 1, 1887, outstanding liabilities		496.75	
			8,626.89
July 1, 1887, amount available	For repairs	47,737.78	62,737.78
	Continuing improvements	15,000.00	
Amount (estimated) required for completion of existing project and repairs			79,612.00
Amount that can be profitably expended in fiscal year ending June 30, 1889			108,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.			

COMMERCIAL STATISTICS.

Amount of commerce and navigation when the work of improvement began under the present project in 1870.

	Number.	Tonnage.
Arrivals	4,793	845,484
Departures	5,534	848,002

Imports	$6,868,163.00
Exports	1,388,862.00
Revenue collected, 1870	1,112,352.82

Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	408	76,227	404	66,229
Sailing vessels	1,358	270,922	1,425	266,982
Total	1,766	347,149	1,829	333,211

Revenue from customs for fiscal year ending June 30, 1887	$598,058.55
Value of imports same year	4,579,835.00
Value of exports same year	1,823,877.00

Greatest draught of vessels, 12 feet 6 inches.

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REMOVAL OF THE BREAKWATER EAST OF THE ENTRANCE TO THE HARBOR OF OSWEGO, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., December 15, 1886.

GENERAL: In compliance with letter from your office, dated November 23, 1886, inclosing petition of citizens of Oswego for the removal of the breakwater east of the entrance of this harbor, I have the honor to report as follows:

The difficulties and dangers of the entrance of the present harbor of Oswego are graphically set forth by my predecessor, Major (now Lieutenant-Colonel) McFarland, Corps of Engineers, in a letter on the subject of lighting, dated February 18, 1882, as follows:

> The difficulty occurs during the season of most active operations in the fall, when heavy gales from the westward, accompanied with storms of rain and snow, prevail, which, with the reaction from the long breakwater, renders it exceedingly difficult for vessels to make the entrance to the harbor, and to miss it means destruction of vessel and cargo and almost certain loss of life.
>
> The difficulty resulting from the reaction from the west breakwater, nearly a mile long, is one that exists at no other harbor on the lakes, for everywhere else the entrance is formed by piers that extend into the lake several hundred yards, and vessels entering have only the natural action of the seas to contend with, while at Oswego the seas coming from the westward and striking the breakwater at a low angle are partly reflected and partly roll along it, accumulating as they go, so that vessels on reaching the entrance have not only the ordinary wave to encounter but, what is far more dangerous, the accumulated wave, which I have myself seen repeatedly pass in solid volume over the tops of the snubbing-posts on the east breakwater, 15 feet above the water-level. * * *
>
> It is the common testimony of the vessel masters sailing to this port that during these heavy gales the breakwater can not be seen at all even during daylight, as it is completely covered by broken water, and the reaction from the breakwater extends this broken water from a quarter to a half a mile into the lake; a vessel entering this broken water begins to tumble about, steers badly, and becomes to some extent unmanageable, the effects increasing as she nears the entrance, and yet she must manage to stand close to the windward side of the channel or run the risk of being destroyed against the opposite breakwater.
>
> The harbor has always been a troublesome one to enter in very bad weather, as it is on the open coast near the eastern end of the lake, and is exposed to the full sweep of the sea coming from the other end, 160 miles to the westward.
>
> The prevailing winds and the most serious gales are from the southwest to northwest; the breakwater runs about northeast by east.
>
> There have been wrecks here from the earliest days, as vessels missing the entrance would go ashore on the rocks under Fort Ontario. There are records of six or seven being cast ashore there in one night.
>
> The number of vessels (wrecks) has decreased since the formation of an artificial harbor, but on the other hand the danger of total destruction of a wreck and loss of life is increased; for while formerly the vessel went ashore in comparatively shallow water, where there was some chance of assistance being given, now if she misses the entrance she is wrecked against the breakwater in deep water a quarter of a mile from shore, where no help can reach her crew. * * *

Since the above letter was written the action of the accumulated wave has been, to some extent, checked by the construction, according to the project of Major McFarland, of a spur westward of the entrance, though I have seen in two gales of this season the waves sweeping unbroken over the snubbing-posts of the east breakwater. The reflected wave, or "back sea," in the phrase of the ship and tug masters, is not affected by the spur, and can be felt in the handling of a ship for a distance of 1½ miles out in the lake, becoming important at a distance of one-quarter to one-half mile.

The contours of the natural lake bottom, as shown in the accompanying plat, indicate an ample sea-way were the east breakwater removed.

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The function of the east breakwater, as a part of the harbor works, is—

(1) To cover the water-front of the eastern part of the city and to create an eastern basin for shipping, in addition to the western already established.

(2) To supplement the southward return of the west breakwater in the protection of the western basin from easterly gales.

For full understanding of this a summary of projects is presented.

Under date of March 7, 1870, my predecessor, Maj. N. Bowen, Corps of Engineers, presented a report on the commerce and commercial need of Oswego, and a project in general terms for an outer harbor. The report, with an elaborate presentation of statistics from 1840 up to and including 1869, showed a rapid increase of its commercial prosperity. The project was for a basin, exterior to the contracted harbor of Oswego, protected by a breakwater; in view of the conflicting interests of the parts of the town lying on the two sides of the Oswego River, it was recommended that the location of this basin be placed in the hands of a Board of Engineer Officers.

A Board convened per Special Order No. 27, Headquarters Corps of Engineers, series 1870, reported its opinion—

I. That the present harbor works of Oswego are insufficient for the accommodation and protection of its commerce.

II. That more wharf room is absolutely needed, and that this can be obtained only by the construction of an outer harbor.

III. That the new work should be located north of the present west pier.

Then, after recommending the trace of the present west breakwater, the report continues:

This project will give over 100 acres area of anchorage between the breakwater and the 12-foot curve at the lowest stage of water, besides 5,000 feet of shore from which wharves may be made out into 12 feet of water. This will double the present capacity of the harbor and suffice for at least thirty years. * * *

The project recommended may be extended towards Sheldon's Point, and may be applied to the east side of the river, should such extension become necessary.

Under date of January 5, 1872, in compliance with a resolution of the House of Representatives of the United States calling for information as to "What extension of the public works on the east side of the mouth of the Oswego River, in the city of Oswego, N. Y., is desirable for the accommodation and protection of the increasing commerce of that port," my predecessor, Major (now Lieutenant-Colonel) Wilson, Corps of Engineers, reported:

While believing that an eastern harbor, in addition to the western now being built, would be extremely desirable and advantageous for the accommodation and protection of the increasing commerce of the port of Oswego, N. Y., * * * that for the present all efforts should be concentrated to complete as rapidly as possible the new harbor on the west side, now being formed, and that when sufficient shelter shall have been obtained to form a good harbor there steps should be taken for the formation of an eastern one, if it is found to be necessary.

Colonel Wilson's report also presented resolutions of the Oswego Board of Trade and letter of D. C. Littlejohn, setting forth rail communications, existing and projected, tending to increase the commerce of Oswego and the importance of its eastern section, as follows:

The New York and Oswego Midland Railroad, a direct and independent line from this city to New York, will be completed about the 1st of August next. The Rome, Watertown and Ogdensburgh Railroad connects us with northern New England. The Lake Shore Railroad is being constructed, running hence to Niagara River, with promised connections to the eastward from this city. The Delaware, Lackawanna and Western Railroad leads from this city to New York, running through the great anthracite coal regions of Pennsylvania; and we are soon to make connections with

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the Southern Central Railroad, giving us a new route to Philadelphia via the coal fields of the Lehigh Valley (Res. B. T.). * * * There are three companies, with roads finished and in process of construction, which are to exercise a large influence in moving the produce of the West to the Eastern States and our Atlantic cities, to wit: the New York and Oswego Midland Railroad, the Rome, Watertown and Ogdensburgh Railroad, and the Boston and Oswego Railroad, terminating of necessity on the east side of the Oswego River. These roads must have access to the waters of Oswego Harbor, with large accommodations in the way of piers, docks, and warehouses for the transfer of produce and property in transitu to the east, and merchandise, coal, iron, and other property destined for use and consumption in the Western States and Canada. * * * (Letter of D. C. Littlejohn.)

In his annual report for the fiscal year 1880, my predecessor, Major (now Lieutenant-Colonel) McFarland, Corps of Engineers, referring to the eastward opening of the western basin, says:

My opinion is that the best way to protect this opening is to reduce it to 350 feet by building from the eastern end of the breakwater, as originally proposed, an arm running southwardly towards the beacon, and thence in front of the eastern half of the city, leaving between the eastern end of the west breakwater now built, and the western end of the eastern now proposed, an opening of 350 feet. * * * The effect of this would be to secure a good entrance in all weathers to all parts of the harbor, western, eastern, and inner, and finally it would give to that half of the city of Oswego which lies on the east side of the river the same harbor advantages that will now be enjoyed by the west side. * * *

The following table shows the commercial statistics of the port from 1870 to 1886, inclusive:

Years.	Revenue.	Exports.	Imports.	Tonnage.	Number.
1870	$1,112,352.82	$1,388,862	$6,868,162	846,743	5,164
1871	798,288.00	.....	6,804,977	801,261	5,153
1872	1,006,172.60	.....	7,018,264	631,983	4,080
1873	897,889.00	1,169,414	7,481,559	641,488	2,501
1874	765,992.67	260,876	7,356,646	562,381	3,846
Average three years	.....	.....	.....	608,617	3,462
1875	570,478.73	1,458,380	5,775,127	446,560	2,539
1876	644,589.46	1,094,065	5,723,897	354,696	2,343
1877	430,748.59	1,096,095	4,122,876	390,466	2,130
1878	416,025.10	960,862	4,718,660	413,315	2,307
1879	507,193.77	832,331	4,993,736	357,320	2,045
1880	746,562.90	786,825	5,142,697	403,685	2,350
1881	853,716.46	1,070,722	5,458,414	402,974	2,459
1882	886,558.77	1,070,184	8,764,551	451,384	2,662
1883	786,423.31	1,102,244	8,313,713	449,260	2,366
1884	697,818.86	1,162,109	6,451,862	349,593	2,144
1885	629,594.78	1,247,537	5,647,042	434,181	2,190
1886	620,599.34	1,182,094	5,160,698	350,201	1,823
Average 12 years	.....	.....	.....	400,303	2,289

In the winter of 1870–'71 a reduction was made in the rates of the Erie Canal, which affected forty-one days of canal traffic in the fiscal year 1871. The new rates held until the close of the canal season of 1874, when a second reduction was made, which affected forty-three days of canal traffic in the fiscal year 1875. No important change thereafter made until the abolition of all rates from and after January 1, 1883.

The effect of the two reductions upon the commerce of Oswego is very apparent in the above columns of tonnage and number of shipping in its harbor. The non-appearance of any like influence from the abolition of tolls plainly indicates that canal transfer from the upper lakes was already confined to Buffalo. The slight changes in the columns of exports and imports are explained by the fact that the shipments from the upper lakes were mainly of timber and grain from American ports.

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The showing of the last twelve years is, therefore, the local traffic of the Ontario Basin and the Upper St. Lawrence. It has shown no regular increase nor decrease, and little fluctuation, during that period. Recently, however, coal, which is the principal export, has been carried in cars loaded at the more westerly mines of Pennsylvania, across the bridges at Niagara and around the head of the lake to Toronto, whence it is distributed, without rehandling, over a railroad system extending as far east as Ottawa. Cars from the easterly mines passing northward by the Utica and Black River Railroad are ferried across the St. Lawrence from Morristown to Brockville and thence distributed. The Delaware and Hudson Canal Company, by its own canals and rails as far as Rouse's Point, has communication with Montreal and the East. In this article there is so great loss, as well as an expense in rehandling, that the export coal trade of Oswego will probably soon be cut down to the supply of places immediately reached by water.

The transportation by the Brockville-Morristown Ferry and Utica and Black River Railroad is also affecting the importations of timber for shipment eastward and southward by the New York Central and Hudson River Railroad. The prospect, as indicated by all information of which I have been able to avail myself, is of decrease rather than of increase in the commerce of Oswego, unless the latter should be determined by an abolition, or important decrease, of tolls on the Welland Canal.

How far the added wharf room has been utilized is shown on the accompanying plat.

Of the railroad projects put forward in 1872 none has been exactly carried out. The New York and Oswego Midland Railroad (now New York, Ontario and Western) is a through line to New York, but not independent, running its trains for the last 50 miles over the rails of the New York, West Shore and Buffalo Railroad. The Boston and Oswego, the promised eastern connections of the Lake Shore, has not been built. The Lake Shore Railroad has been bought by the Rome, Watertown and Ogdensburgh. The two termini coalesce into a way station, and finally the consolidated road owns land which secures access to the western basin, but has not laid its tracks for that purpose. The Southern Central Railroad of New York crosses the Lake Shore Railroad and carries its Lehigh Valley coal to lake water at Fair Haven.

The protection of the front of the western basin is nearly completed by the old and new western breakwaters. The line from the shoulder of the old breakwater to the harbor end of the return of the new has a bearing (true) of north 17° east, that from the same point to the outer end of the light-house pier has the bearing north 27 degrees 45 minutes east. The eastern breakwater, in its present extension, covers about one-half the included sector, and also undoubtedly breaks the force of waves which would, without it, strike the east face of the return and spread it at the harbor entrance. Storms from the eastward of north are, however, comparatively rare, and winds coming from the quarter thus left open have a sweep of only about 30 miles upon the lake.

From the facts above presented I draw the following conclusions:

As the present shipping in tonnage and numbers is less than one-half that for which the western basin was planned, and as the railroad projects expected to give especial importance to the eastern water-front have not been carried out, I find no occasion for an eastern basin.

While the eastern breakwater, in its present extension, offers a slight protection from infrequent easterly storms, it presents a serious and

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dangerous obstacle to entering the harbor during the more frequent and more perilous westerly gales.

I have, therefore, the honor to recommend its removal.

The petition of Thomas S. Mott and others is herewith returned.

I have the honor to be, very respectfully, your obedient servant,

CARL F. PALFREY,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF THE BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, February 15, 1887.

GENERAL: The Board of Engineers, to which was referred the petition of Thomas S. Mott and others for the removal of the east breakwater in Oswego Harbor, together with the report of Capt. C. F. Palfrey, Corps of Engineers, upon the same subject, have the honor to submit the following report:

The piece of breakwater the removal of which is asked is located 351 feet north of east from the eastern end of the west breakwater. It is 213 feet in length, and at its western end has a north and south return 35 feet long. The width of the breakwater is 35 feet, and it is located in from 23 to 30 feet depth of water, averaging say 24 feet. The top of the breakwater for one-third of its width on the lake front rises 13 feet above the surface of the water, while on the harbor side the height of the breakwater is but from 3 to 5 feet above the same surface. The cubical contents of this piece of breakwater above the bottom of the lake is about 10,000 cubic yards, and it forms the western end of the "eastern breakwater," so called, which has been projected for a total length of 2,700 feet, as the outer line of a harbor to be built along the eastern front of the city.

The size of the west harbor, the small extent to which its shore-line is now occupied by wharves, and the relative magnitude of the trade of the port of Oswego for the past twelve years, compared with its trade from 1870 to 1874 inclusive (as is more particularly set forth in Captain Palfrey's report of December 15, 1886), would seem to make it inadvisable to complete at present the east breakwater and east harbor.

The difficulties and dangers which arise for the commerce of the harbor of Oswego during westerly gales from the accumulated waves along the face of the west breakwater and the position of so much of the east breakwater as has already been constructed, are fully set forth in Captain Palfrey's letter, in which he quotes largely from reports of his predecessors in charge of these works in substantiation of this statement.

There can be no question as to the necessity of some remedy for these evils, and the shipping interests of the locality favor the removal of so much of the east breakwater as has already been built.

Considering the several methods that have been suggested for furnishing the relief required, namely, (*a*) by the introduction of spur breakwaters normal to the exterior face of the west breakwater; (*b*) by filling with a breakwater construction the gap now existing between the west and east breakwaters; and (*c*) by the removal of the east breakwater, the Board of Engineers, after careful consideration of the subject, rec-

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ommend the removal of the east breakwater. It is estimated that the cost of this removal, at $1.50 per cubic yard, will amount to $15,000.

The papers in the case are herewith returned.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel, Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
D. C. HOUSTON,
Lieut. Col. of Engineers, Bvt. Col.

The CHIEF OF ENGINEERS, U. S. A.

N N 6.

IMPROVEMENT OF SACKETTS HARBOR, NEW YORK.

OBJECT.

To deepen the harbor within Ship-house Point, over an area of about 15 acres, to 12 feet at extreme low water.

This project was adopted in 1881. Previous to 1881, $6,000 was expended in 1826–'28, in deepening the same area.

PRESENT PROJECT.

To limit the excavation to an area of about 6 acres, and to define the entrance and provide a mooring-place by a crib 18 feet square, placed upon the end of the shoal extending into the harbor from Ship-house Point.

Also, to check shore-drift by extending jetties across the end of Ship-house Point, from the crib above described to the bay outside the point.

PRESENT WORKS.

An area of 6 acres has been deepened as above described to 12-foot depth, and the 18-foot crib has been built and placed.

The channel has 12 feet at extreme low water.

Operations, none.

REMARKS.

The depth of water in this harbor is ample for the present needs of its commerce, the usual draught being from 7 to 9 feet.

In order that the crib be a valuable mooring-place, it needs suitable cleats or rings. It is proposed to place these during this season.

The commerce of this port shows a slight revival during the past few years. About 1,000,000 pounds of fresh fish were shipped hence by rail during the past year. A planing mill has lately been established, whose shipments will probably utilize the full depth of water provided.

Money statement.

July 1, 1886, amount available	$72.11
July 1, 1887, amount available	72.11
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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COMMERCIAL STATISTICS.

Name of harbor, Sackett's Harbor, N. Y. Collection district, Cape Vincent, N. Y. Nearest light-house, Sackett's Harbor, N. Y. A fixed white light of the fifth order on Horse Island, 1¼ miles west of town. Nearest work of defense, Fort Ontario, N. Y.

Amount of commerce and navigation when the work of improvement begun under the present project in 1883.

Description.	Number.	Tonnage.
Arrivals	178	5,068
Departures	177	5,009

Imports	$21,505.00
Exports	9,300.00
Revenue collected, 1883	3,430,56

Arrivals and departures of vessels during the fiscal year ending June 30, 1887.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	76	1,777	76	1,787
Sailing vessels	70	3,164	62	3,049
Total	146	4,941	138	4,836

Revenue from customs for fiscal year ending June 30, 1887	$2,100.28
Value of imports, same year	40,199.66
Value of exports, same year	None.

Greatest draught of vessels, 9 feet.

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APPENDIX O O.

IMPROVEMENT OF OGDENSBURGH HARBOR, ON THE RIVER ST. LAWRENCE; OF HARBORS ON LAKE CHAMPLAIN, AND OF GRASS AND TICONDEROGA RIVERS, NEW YORK, AND OF OTTER CREEK, VERMONT..

REPORT OF MAJOR MILTON B. ADAMS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORK.

IMPROVEMENTS.

1. Ogdensburgh Harbor, New York.
2. Grass River (at Massena), New York.
3. Breakwater at Rouse's Point, Lake Champlain, New York.
4. Swanton Harbor, Vermont.
5. Breakwater at Gordon's Landing, Lake Champlain, Vermont.
6. Plattsburgh Harbor, New York.
7. Burlington Harbor, Vermont.
8. Otter Creek, Vermont.
9. Ticonderoga River, New York.
10. Narrows at Lake Champlain, New York and Vermont.

EXAMINATIONS.

11. Channel between North and South Hero Islands, Lake Champlain, known as "The Gut."
12. Waddington Harbor, New York.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., July 26, 1887.

GENERAL: I have the honor to transmit herewith annual report for river and harbor works in my charge during the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O O 1.

IMPROVEMENT OF OGDENSBURGH HARBOR, NEW YORK.

A project was formed for the improvement of this harbor by a Board of Engineer Officers in 1868, which provided for dredging the channel of the Oswegatchie River below the bridge, deepening the channels along the city front on the St. Lawrence River and across the bar

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northeast of the light-house, and the construction of a pile-pier to prevent the water of the Oswegatchie spreading over the bar or shoal between these channels. The pile-work was only recommended in the event of the water of the Oswegatchie not following the lines of the deepened channels after the dredging had been completed.

The dredging, as provided for in the project, was completed in 1876, and the piling was found unnecessary; consequently, operations were confined to dredging the channels, which were left in good condition.

For a few years following the completion of the project of 1868 there was a suspension of operations. The harbor was ordered re-surveyed in 1879, which, being done in 1880, showed considerable shoaling of the channels during these four years of inactivity; and, furthermore, that the obstructions in the channels were mainly due to saw-dust and other waste products of saw-mills which had been thrown into the Oswegatchie River in violation of local regulations forbidding it. The amount of damage, or shoaling, as shown by the survey of 1880, was 40,000 cubic yards, which it was estimated would cost $12,000 to remove, so as to place the channels in good condition again. More or less of this same kind of injury to the channels still continues, in defiance of law and the efforts at its enforcement that have been made.

The original project was estimated to cost $175,000, and there had been expended up to 1880, exclusive of $3,000 for a survey in 1852, $107,000, leaving $68,000 still due the general improvement, owing to the piling of the project not being required.

In 1882 it was recommended to place the harbor in condition to admit the largest vessels that will be able to pass the enlarged Welland canal at an estimated cost of $76,000 as follows:

Outer bar, 1,500 feet by 400 feet by 3.1 feet, about 80,000 yards, at 30 cents per yard	$24,000
Near Rome, Watertown and Ogdensburgh Railroad wharves, 1,150 feet by 300 feet by 3 feet, 40,000 yards, at 40 cents per yard	16,000
Oswegatchie mouth, 1,000 feet by 300 by 1.8 feet, 20,000 yards, at 20 cents per yard	4,000
Channel along city front, 7,200 feet by 150 feet by 4 feet, 160,000 yards, at 20 cents per yard	32,000
Total	76,000

This estimate was intended to provide for a depth of 15 feet in the channels and 16 feet over the outer bar.

Operations have been carried on in accordance with the above scheme of improvement since 1882, and under contract dated December 13, 1883; August 26, 1884; September 12, 1885, and November 19, 1886. There were 35,345 cubic yards removed under the first contract from the vicinity of the Central Vermont Railroad wharves and from the channel near by, connecting with the St. Lawrence River; 48,194 yards were removed under the second, from the channel near the Rome, Watertown and Ogdensburgh Railroad wharves and that leading therefrom to the St. Lawrence River; 14,988½ yards were removed from the angles in the channels, under the third contract; and the fourth contract, which is now in operation, comprehends the removal of 50,000 yards, mostly from the channel along the city front.

The prices paid under these contracts, owing to the development of harder material in the bottom than the original estimate contemplated, were such that they seemed to indicate that the total figures in the estimate would prove too small, until the fourth contract was made, which is at prices low enough to warrant an expectation that the entire

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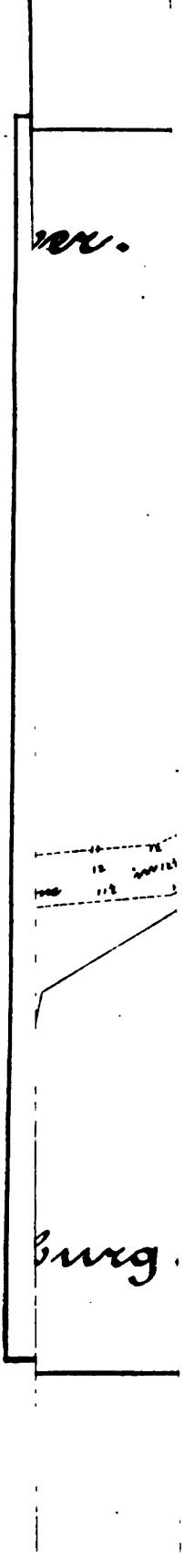

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amount of the original estimate may not be exceeded, notwithstanding the obstacles which are now known to exist.

With the completion of the present contract, during this working season, there will have been some 150,000 cubic yards removed from the channels of this harbor at a cost of $34,543.04, consuming the available funds; and there will remain about the same amount, mostly in the city-front channel, to be removed, in order to complete the scheme of improvement as per the estimate. There are $30,000 asked for this harbor to be applied to dredging operations.

Money statement.

July 1, 1886, amount available		$273.90
Amount appropriated by act approved August 5, 1886		10,000.00
		10,273.90
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,439.61	
July 1, 1887, outstanding liabilities	265.85	
		3,705.46
July 1, 1887, amount available		6,568.44
Amount (estimated) required for completion of existing project		73,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of Harbor, Ogdensburgh, N. Y. Collection district, Oswegatchie. Nearest light-house, Ogdensburgh, N. Y.

Tonnage of vessels which entered and cleared during 1886.

Entered	tons..	162,666
Cleared	do...	165,092

Tonnage of vessels which entered and cleared from and to foreign ports during 1886.

	Entered.	Cleared.
	Tons.	*Tons.*
American vessels	17,507	15,917
Foreign vessels	92,741	82,889
Total	110,248	98,806

Amount of merchandise received and shipped coastwise in 1886.

Received:		
Lumber	feet..	22,985,920
Wheat, corn, and oats	bushels..	4,514,699
Coal	tons..	49,292
Packages	do....	23,940
Shipped:		
Iron ore	tons..	10,669
Packages	do....	32,660
Lumber	feet..	1,000,695

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Amount of merchandise received and shipped to foreign ports in 1886.

Received:		
Barley	bushels..	449,614
Lumber	feet..	11,729,012
Packages	tons....	11,200
Shipped:		
Packages	tons..	1,000
Coal	do....	25,000

The above was obtained through the kindness of the collector of customs.

OO 2.

IMPROVEMENT OF GRASS RIVER, AT MASSENA, NEW YORK.

There have been no operations under the above head during the past year.

The project for this improvement was adopted in 1881, and appears in the Report of the Chief of Engineers for that year, pages 2457 to 2460. It contemplates the formation of a channel from the St. Lawrence River to Massena Village, a distance of about 7½ miles by water, with a least width of 40 feet and a least depth of 4 feet, at an estimated cost of $12,000.

The items of the estimate are as follows:

Excavation at Rapids, 2,000 yards, at $4 per yard	$8,000
Excavation at Haskell's Wharf, 1,500 yards, at $1 per yard	1,500
Excavation at other points, 3,000 yards, at 50 cents per yard	1,500
Contingencies, etc	1,000
Total	12,000

Under an appropriation of $3,000 for this work proposals were invited in April, 1883, for the removal of 2,000 cubic yards of obstructing material at Rapids, the first item as above, and in response only one bid was received, at the rate of $6 per yard. It was evident, therefore, that it would cost at least $12,000 to make the improvement at that point, and that the funds available were only sufficient to remove one-fourth of that single obstruction. As no benefit could arise from the work, unless completed, and as the work could be carried on more economically when the improvement of at least one place could be accomplished in one season's operations, an additional appropriation of $9,000 was asked for, and no further action has been taken since.

The balance of the appropriation, after paying the cost of advertising, etc., amounting to $2,948.60, is now to the credit of the improvement.

In case additional funds become available for this work, it is expected to apply them, together with the balance now on hand, in dredging operations according to the original plan.

Money statement.

July 1, 1886, amount available	$2,948.60
July 1, 1887, amount available	2,948.60
Amount (estimated) required for completion of existing project	17,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	17,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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COMMERCIAL STATISTICS.

Name of harbor, Grass River (Massena), New York; collection district, Oswegatchie; nearest light-house, Ogdensburg, N. Y.

A steam ferry-boat makes regular trips from Cornwall, in Canada, opposite the mouth of Grass River on the St. Lawrence River, to a point a mile below Massena, beyond which the obstructions in the channel will not allow the boat to go. The collector of customs was unable to furnish any statement of receipts, and it is presumable that little or nothing was collected.

O O 3.

BREAKWATER AT ROUSE'S POINT, LAKE CHAMPLAIN, NEW YORK.

Operations have been carried on during the year in accordance with the original plan, adopted in 1885, and under contracts dated August 22, 1885, and October 28, 1886.

The first contract was made with Richard F. Hawkins, of Springfield, Mass., for the construction of 800 linear feet of the breakwater adjoining the shore; the other contract was made with John L. Johnson, of Fulton, N. Y., the lowest bidder, after due advertisement and opening of bids, and comprehends the extension of the 800 feet shore section above 550 feet further into the lake.

The progress that was made during the latter part of last season's operations was not such as had been expected. Considerable difficulty was experienced in handling and placing the large stones so as to make anything like a fair paving of them, and notwithstanding the efforts made by the contractor to hurry matters, by sending to a distance to secure the services of an experienced foreman, increasing his force of workmen, and the number of derricks used in handling the stone, the contract could not be completed on time.

The delay was no doubt greatly due to the novel character of the work, involving the handling, sledging, and placing of large stones (1 to 3 tons weight) in such a manner as to form a paving or sort of inclined dry wall of them, and I was, therefore, pleased to recommend an extension of time under this contract, and glad when the time for its completion was extended to September 30, 1887.

It is confidently expected the first contract will be completed within the extension of time granted on it.

Work under the second contract has been progressing fairly well. Most of the rubble-stone required in the foundation of this 550-feet section was placed during the winter, and will now have ample time for thorough settlement before the large stones are added as a facing and crowning along this portion of the structure.

The second contract does not require completion until November, 1888, and it is believed it will be finished well within that date.

The good effects of this improvement are apparent along the town front, at the docks, by the comparative calmness of the water there now during southeasterly storms, which formerly caused considerable commotion.

As funds become available for this work they are to be applied under the approved project, which contemplates the construction of a straight breakwater of rubble and large stone extending from Stony Point in the general direction of the southern point of the 6-foot curve south of Windmill Point until the 18-foot curve is reached, a total distance of

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about 2,000 feet. The estimated cost of the breakwater was placed at $110,000.

To date there have been two appropriations for this improvement, amounting to $55,000, which has either been consumed or placed under contract.

Money statement.

July 1, 1886, amount available		$26,387.46
Amount appropriated by act approved August 5, 1886		20,000.00
		46,387.46
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$17,748.97	
July 1, 1887, outstanding liabilities	2,491.71	
		20,240.68
July 1, 1887, amount available		26,146.78
Amount (estimated) required for completion of existing project		55,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		55,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Name of harbor, Rouse's Point, N. Y.; collection district, Champlain; nearest lighthouse, Windmill Point.

Vessels entered and cleared.

Years.	Entered.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
1884	892	90,290	874	78,445
1885	860	84,104	783	81,361
1886	877	82,449	866	82,889

Imports and exports, 1884, 1885, 1886.

Articles.	Quantity.	Value.	Duty.	Total value of exports.
1884.				
Lumber ..... feet, B. M..	98,118,600	$1,158,642	$173,972.14	.....
Other merchandise	.....	134,590	23,730.70	.....
Total	.....	1,293,232	197,702.84	965,429
1885.				
Lumber ..... feet, B. M..	87,127,983	1,052,022	160,401.60	.....
Other merchandise	.....	171,093	23,104.13	.....
Total	.....	1,223,115	183,505.63	553,645
1886.				
Lumber ..... feet, B. M..	93,388,176	1,238,925	171,206.26	.....
Other merchandise	.....	139,028	5,078.64	.....
Total	.....	1,377,953	176,284.90	1,429,733

The above was obtained through the kindness of the collector of customs.

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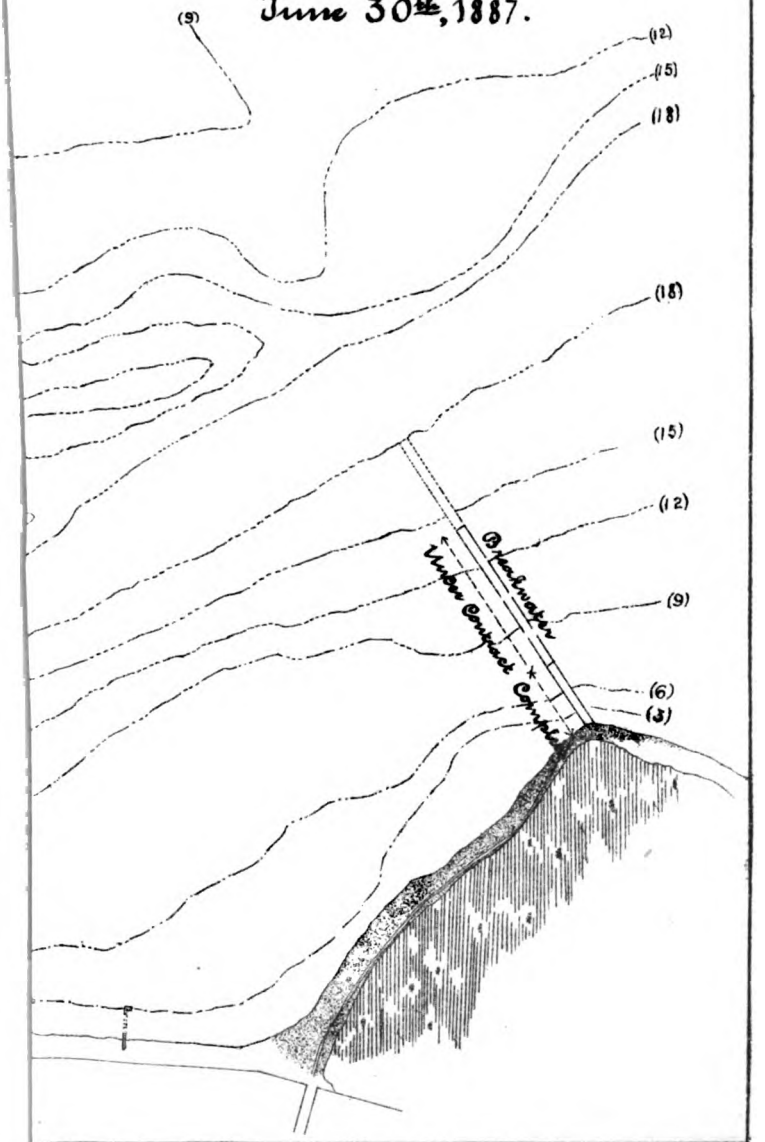
ves Point harbor N.Y.

accompany the annual report of

Major M.B. Adams.

June 30th, 1887.



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O O 4.

IMPROVEMENT OF SWANTON HARBOR, VERMONT.

The project was adopted in 1873, and the undertaking was thought to be of doubtful expediency at that time, as shown by the report of the officer then in charge. (See Annual Report, Chief of Engineers, 1873, page 396.) Subsequent events have shown that the doubts as to the propriety of trying to anticipate the wants of the harbor in its improvement, which were expressed in submitting the original report and project, were well grounded.

The appropriations which have been made from time to time have been expended in the construction of a breakwater; the docks and wharves it was designed to protect were never built, however, and the shipping facilities at the harbor now, instead of being located where they would have received some protection from the breakwater, are clustered around two docks three-fourths of a mile distant from it.

In consideration of the foregoing facts, and the uncertainty attending the location of docks and wharves that were possibly to be built, it has been recommended for some years that no further appropriation be made for this harbor until the future development of the shipping and commercial interests indicate more definitely the direction in which improvement should be made for their protection.

According to the preliminary examination and survey made in October and December, 1884, and reported in January, 1885, it would seem that the conditions for indicating more definitely the direction in which improvement should be made have arrived.

Should the work be undertaken, however, instead of following the exact scheme of that report, I would recommend the building of a breakwater nearly parallel with and about 1,000 feet distant from the shore, from a point 200 feet north of the outer end of the existing structure until a position directly west of the docks is reached, and the extension of the existing structure somewhat nearer shore; by which means it is thought the increased harbor capacity afforded would justify the change from the plan of the above report, submitted in January, 1885.

Money statement.

July 1, 1886, amount available	$326.93
July 1, 1887, amount available	326.93
Amount (estimated) required for completion of existing project	169,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	80,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Name of harbor, Swanton, Vt.; collection district, Vermont; nearest light-house Point aux Roches.

Arrivals and departures of vessels in 1885.

Description.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	*1	.....	*1	.....
Sailing vessels	20	2,000	20	2,000
Vessels in tow (barges)	150	15,000	150	15,000

*Daily.

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The revenue from customs, value of imports and exports, etc., were not obtainable. Among the imports were 14,200 tons of coal and 800 tons of iron ore, also some 400,000 pounds of general merchandise.

No statement of commerce and navigation for the calendar year 1886 was obtainable from the collector for the district.

OO 5.

BREAKWATER AT GORDON'S LANDING, LAKE CHAMPLAIN, VERMONT.

The project for this improvement was adopted in 1887, and has for its object the construction of a breakwater composed of rubble and large stones and extending in a straight line from a point some 250 feet south of the dock or landing, where the water is about 3 feet deep at lowest stage, to a point on the 18-foot curve and about 100 feet north of the line drawn from the dock to Cumberland Head.

At inception the object of the undertaking seems to have been the affording of increased shelter on the west shore of Grand Isle, Lake Champlain, which incidentally has involved the protection of the dock or landing which gives the improvement its name.

When the appropriation of $18,750 was made for this work, in the act approved August 5, 1886, no survey of the locality, with a view to improvement, had been made. The general character of the shore was known, however, from the Coast Survey maps, and the most important place on the west shore of Grand Isle, at which some protection was believed to be possibly advantageous, had been cited. Consequently, and as a subsequent step in the order of procedure, it became necessary to make a thorough examination and survey, and to design a structure that would afford the desired shelter.

The examination and survey were made October, 1886, and a map, drawing, report, etc., were prepared by Assistant Engineer John C. Churchill, jr., which covered the facts in regard to the locality as well as my recommendations respecting the proposed structure to be built for protection, all of which were duly considered by the Board of Engineers and received your approval.

The report covering the examination and survey of the locality, and inclusive of a description of my proposed modifications in the structure designed for protection, was submitted January 12, 1887. Such was the time consumed, however, in connection with the examination of the plans and specifications for this new work that it could not be regularly advertised until June 28.

The cost of this undertaking has been placed at $38,158.72.

Money statement.

Amount appropriated by act approved August 5, 1886	$18,750.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	336.10
July 1, 1887, amount available	18,413.90
Amount (estimated) required for completion of existing project	19,408.72
Amount that can be profitably expended in fiscal year ending June 30, 1889	19,408.72
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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COMMERCIAL STATISTICS.

Shipments from the landing in the years 1882 *and* 1885.

Articles.		1882.	1885.
Apples	barrels..	1,898	552
Eggs	cases..	116	209
Butter	tubs..	1,392	607
Grain and beans	pounds..	641,308	532,988
Wool	do....	.....	19,241

Also many shipments of wood, live stock, and other farm products. There are also receipts of coal, tile, brick, etc., as well as the merchandise for five merchants on the island.

SURVEY OF GORDON'S LANDING, LAKE CHAMPLAIN, VERMONT.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., January 12, 1887.

GENERAL: I have the honor to acknowledge the return of drawings and specifications pertaining to the proposed breakwater construction at Gordon's Landing, on Lake Champlain, with your indorsement of January 10, 1887.

The drawings are again respectfully transmitted, and with them copies of a letter and estimate which were prepared and forwarded yesterday, as addenda to the papers previously submitted for approval; also a report of survey of Gordon's Landing, by Assistant Engineer John C. Churchill, jr.

The specifications and letter requesting authority to print and advertise are also inclosed herewith, in order to preserve the entirety of the communications, and for the reason that, if the action on the project is favorable, matters will be expedited if the specifications are acted on at once, too; and in the event of unfavorable action on the project, there will be no increased delay in consequence of returning the specifications with the faulty project for amendment.

Referring to that part of your indorsement calling attention to the wording of the law which appropriates money for this undertaking, I would respectfully state that that matter was duly considered in the preparation of the project comprehended in the inclosed papers.

It would appear that the law does not absolutely fix the location of the structure; for it makes reference to Ex. Doc. No. 81, Forty-ninth Congress, first session, which not only does not confine the structure to the 12-foot curve, but shows clearly and decidedly the meagerness of the information on which that report to Congress was necessarily based. It seems reasonable to conclude, therefore, that this restriction in the law is for the purpose of limiting the magnitude of the undertaking, and not to embarrass the engineer in locating the work.

The reports to Congress, in connection with the instructions of January 21, 1886, ordering it, shows conclusively that the location mentioned therein was merely an imaginary one, and it is hard to conceive that Congress would order an outlay of thousands of dollars on such an uncertain plan. Probably the clew to this restriction in the law is found in the clause of the report immediately preceding the one which outlines an imaginary structure, such as was thought might afford possible

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relief at Gordon's Landing, which states that the water is 83 feet deep only 1,000 feet from shore, and that "it would doubtless be an expensive undertaking to effect shelter and proper harbor capacity at this point."

The project herewith submitted is based on no such uncertain data as obtained for the report that went before Congress, but on a careful survey of the locality by Assistant Engineer John C. Churchill, jr. (see his report herewith), and the wants of the locality, as well as the configuration of the bottom and shore, have been carefully considered in the preparation of this project.

The structure herein recommended will cost no more to build than one 1,200 feet long and V-shaped, with the ends in 12 feet and the angle in 18 feet of water, but it is assuredly regarded as affording a better harbor than a continuous V-shaped structure would afford, particularly if its ends are carried as near shallow water as the 12-foot curve would bring them.

Since writing the letter of yesterday and forwarding the estimate for the entire undertaking a careful reading of Mr. Churchill's report on the survey at Gordon's Landing shows that an allowance of 25 per cent. was made for settlement of rubble-stone foundation into the clay bottom, which I regard as too great. I think that 10 per cent. will more than cover it. This correction applied to the estimate will make the shore-arm cost, with contingencies, $38,158.72 and the lake arm $32,546.14, or $70,704.86 for the entire undertaking at the advanced cost of materials.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., December 29, 1886.

MAJOR: I have the honor to submit herewith my report of a survey of Gordon's Landing, Lake Champlain, Vermont, made under your instructions during the month of October, 1886, together with map showing proposed location of breakwater, plan of construction, and estimate of cost.

Gordon's Landing is situated in a small bay on the west shore of Grand Isle, about 4 miles from its northern and 4¼ miles from its southern end.

It is protected to the northwest by Cumberland Head, the southern point of which is 1¼ miles west-northwest from the dock, but is exposed on the north, where the wind has a reach of 6 miles; on the west, where the reach is 5 miles; and south, where the reach is 12 miles.

Careful inquiry from numerous steamboat captains and pilots and residents about Gordon's Landing showed that the heaviest winds and those which most affected the landing were those from the southwest and south, and the section of the U. S. Coast Survey chart, which is submitted with the map of Gordon's Landing, proves that those winds have the greatest reach, viz, 5 to 12 miles.

It was ascertained that the dock and approach to it at the landing were carried away during a heavy southwest storm a few years ago.

Opposite and southwest of the dock is a solid rock reef, extending from the shore 400 feet into the lake, near the outer edge of which are the 6, 9, and 12-foot curves.

North of the landing, also near the point, the same curves approach to within 50 feet of each other.

In your original report, dated February 12, 1886, as to the feasibility of building a breakwater at Gordon's Landing, the form and location proposed was that of a V-shaped breakwater, extending from 12-foot curve to 12-foot curve, with its apex in 18 feet, inclosing the bay; the structure to be similar to that at Rouse's Point, N. Y.

The configuration of the bottom about the landing makes a modification of the proposed location necessary, while the form and construction remain the same.

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It would appear that the best location for the breakwater would be as follows: A shore-arm, to commence at a point a few hundred feet south of the dock, near the shore-line, in about three feet of water at the low stage; thence out to the 18-foot curve, crossing a line drawn from the dock to the southern point of Cumberland Head, with a detached breakwater towards the north as a protection from north winds.

The latter piece is not so important as the first, as the winds from the north are not severe.

The map and plan submitted herewith give the location as outlined above, the structure to be built of stone, very similar to that at Rouse's Point, N. Y., which is the cheapest structure that can be built here, having at the same time sufficient stability.

The shore-arm is 800 feet long, and begins in about 3 feet of water, at a point 250 feet south of the dock, thence to the 18 foot curve, crossing the line drawn from the dock to the southern extremity of Cumberland Head, and reaching the 18-foot curve at a point 100 feet north of said line.

This arm alone will afford complete protection to the dock and a large part of the bay from west and south winds, which, as has been before stated, are the most severe.

The first 300 feet will rest on the solid rock reef, which extends south rom the dock, while the remainder will rest on the clay bottom, where there will be considerable settlement.

The lake arm is 500 feet long, commencing 175 feet north from the outer extremity of the shore-arm and extending towards the point of land north of the landing.

This portion of the breakwater will rest on clay. In the estimate of the amount of rubble-stone required, 25 per cent. was allowed for settlement on those portions of the breakwater resting on the clay bottom.

The location described, leaving openings to the west and north, gives a harbor easy both for entrance and exit, and having nine acres of good anchorage outside of the 9-foot curve.

During the season two steamers stop daily at Gordon's Landing.

The amount of business done here can be seen from the following statement obtained from D. J. Center, proprietor of the dock and warehouse.

Shipments from Gordon's Landing during the years 1882 *and* 1885.

Articles.	1882.	1885.
Apples ..... barrels..	1,898	552
Eggs ..... cases..	116	209
Butter ..... tubs..	1,892	607
Grain and beans ..... pounds..	641,308	582,998
Wool ..... do....	.....	19,241

Also many shipments of live stock and farm produce, and wood both for fuel and the manufacture of pulp.

There are six merchants on the island, five of whom receive their goods at this landing.

There are also receipts of coal, tile, brick, and lumber in considerable quantities.

Very respectfully,

JOHN C. CHURCHILL, JR.,
Assistant Engineer.

Maj. M. B. ADAMS,
Corps of Engineers, U. S. A.

LETTER OF INSTRUCTIONS TO THE BOARD OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1887.

SIR: The Board of Engineers for Fortifications and for River and Harbor Improvements is desired to take into consideration and report upon the subject of a breakwater at Gordon's Landing, Lake Champlain, for which an appropriation was made in the river and harbor act of

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August 5, 1886, and will report its views upon the most proper location to meet the requirements of the appropriation, as also upon the best plan of construction to be adopted.

In this connection the inclosed papers, containing plan and estimates for the work, received from Maj. M. B. Adams, Corps of Engineers, * * * are transmitted to the Board for its information, and if deemed necessary, one or more members of the Board will be authorized to visit the locality, or Major Adams will be instructed to appear personally before the Board and to furnish any additional data that may be desired.

Papers to be returned.

By command of Brigadier General Duane:

Very respectfully, your obedient servant,

JOHN G. PARKE,
Bvt. Maj. Gen., U. S. A.,
Colonel of Engineers.

Col. THOS. LINCOLN CASEY,
Corps of Engineers, President Board of Engineers for Fortifications and for River and Harbor Improvements.

REPORT OF BOARD OF ENGINEERS.

THE BOARD OF ENGINEERS,
New York, February 1, 1887.

GENERAL: The Board of Engineers, to which was referred by Department letter of January 18, 1887, the "subject of a breakwater at Gordon's Landing, Lake Champlain," with directions to "report its views upon the most proper location to meet the requirements of the appropriation, as also upon the best plan of construction to be adopted," have the honor to report—

That the law covering the appropriation for a breakwater at Gordon's Landing, Lake Champlain, is as follows:

For a breakwater at Gordon's Landing, on Lake Champlain, to be built on the 12-foot curve mentioned in the papers accompanying the report of the Secretary of War to the Senate, dated March 1, 1886 (Ex. Doc. No. 81, Forty-ninth Congress, first session), $18,750, act of August 5, 1886, section 1.

A careful examination of the location, as shown by the excellent survey of Assistant Engineer John C. Churchill, jr., and its accompanying memoir, makes it certain that a breakwater suitable for the protection of Gordon's Landing can not be constructed, if, in the literal language of the law, it is "to be built on the 12-foot curve mentioned in the papers accompaning the report of the Secretary of War to the Senate, dated March 1, 1886," the words, "on the 12-foot curve" being construed to mean at, or in contact with, the 12-foot curve.

If it should be decided that a breakwater should be built here then, considering the position of the landing with reference to the adjacent shores and headlands, the nature of the bottom, the reach of the winds, and the compass points of the strongest gales, the Board are of the opinion that the best plan of construction to be adopted is to take the southern portion of the work projected by Major Adams, which it considers sufficient for the protection of this landing. This piece is 800 feet in length, and, commencing at a point 250 feet south of the dock near the shore-line in about 3 feet of water, at low stage, is diverted out to the 18-foot curve, crossing a line drawn from the dock to the

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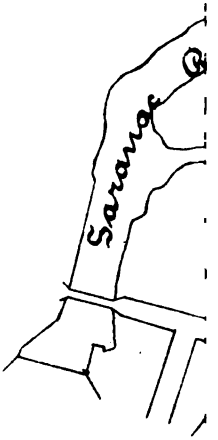
Bor. N. Y.



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M as between dotted lines

during season of 1887.

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southern point of Cumberland Head, and reaching the 18-foot curve at a point 100 feet north of that line. The cross-section of this breakwater, as adopted by Major Adams, meets with the approval of the Board, and is deemed sufficient for the protection of this location.

The papers accompanying the letter of the Chief of Engineers of January 18, 1887, are herewith returned.

Respectfully submitted.

THOS. LINCOLN CASEY,
Colonel Corps of Engineers.
HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen.
C. B. COMSTOCK,
Lieut. Col. of Engineers
D. C. HOUSTON,
Lieut. Col. of Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

O O 6.

IMPROVEMENT OF PLATTSBURGH HARBOR, NEW YORK.

The original project for the improvement of this harbor was adopted probably in 1836, the date of the first appropriation, and proposed the construction of a breakwater about 1,000 feet east of the steamboat docks.

There were 1,250 linear feet of breakwater constructed between the years 1836 and 1875, at which latter date the last modification of the project was completed. This modification, made in 1870, provided for an extension of the former structure to the southeast, the dredging of some shoal areas within the breakwater, and the protection of a portion of the adjacent beach by a revetment.

Since 1875 operations have been confined to necessary repairs of the breakwater and the dredging of limited areas between it and the steamboat docks.

The report and survey of the mouth of Saranac River, Plattsburgh, N. Y., which has appeared as House Ex. Doc. No. 72, Forty-eighth Congress, second session, comprehends the dredging of 110,000 cubic yards there, and would amount to a considerable extension of the limited areas of dredging operations, and therefore may be said to constitute a further modification in the project for this harbor improvement.

There have been no operations at this harbor since 1884, at which date some 3,022 cubic yards were dredged from near the docks and the funds were exhausted.

The appropriation of $5,000, by act approved August 5, 1886, has been pledged under contract dated March 9, 1887, but by its terms work is not likely to be commenced before August, 1887; nevertheless the entire amount of the work comprehended in the contract, being the dredging and removal of 25,000 cubic yards from in front of the docks, is to be accomplished by November 30, 1887, which will consume the available funds.

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As additional funds become available for this harbor it is expected to apply them in dredging operations so as to afford sufficient depths for the boats that frequent the harbor, and in making repairs to the breakwater as required.

Money statement.

July 1, 1886, amount available	$88.06
Amount approved by act appropriated August 5, 1886	5,000.00
	5,088.06
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1866	184.41
July 1, 1887, amount available	4,903.65
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	7,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Name of harbor, Plattsburgh, N. Y., collection district, Champlain; nearest lighthouse, Cumberland Head; two beacon lights at Plattsburgh.

Arrivals and departures of vessels during the year 1886.

Class.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	760	350,900	760	350,900
Sail	40	3,360	40	3,360
Canal boats, etc	725	65,250	725	65,250
Total	1,525	419,510	1,525	419,510

Value of goods imported	$1,754
7,500 tons of coal	30,000
Value of domestic goods, miscellaneous merchandise	27,000
Value of goods shipped:	
Iron ore	81,000
Lumber	110,000
Other merchandise	90,000

The above was received through the kindness of the collector of customs.

OO 7.

IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

The first project for the improvement of this harbor was probably adopted in 1836.

Modifications of the original project have been made from time to time so as to afford adequate protection to the increasing commercial and shipping interests of the harbor.

In 1874 a modification was proposed whereby an extension, 2,000 linear feet westward, was effected; in 1884 an extension to the south was proposed by the officer then in charge; and again, in 1886, a plan for further extension, both to the north and to the south, which outlined

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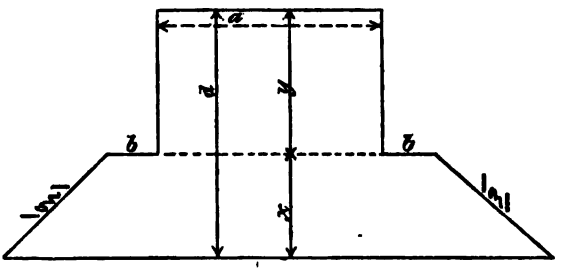
the proper locations for these extensions, covering considerable of the shore in both directions, received the consideration of the Board of Engineers and was approved.

In connection with this plan for the future location of work at this harbor there was also submitted a modified method of construction that was approved; and as it lessens the cost of such work very much, is of easy and general application, besides being, as far as known, absolutely unique in its deduction and application, it is deemed of sufficient importance to introduce into this report, in hopes that it may be found useful to others. I cannot do better, therefore, than to copy the report that was submitted with the plan, which reads as follows:

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., April 29, 1886.

GENERAL: Having had occasion to calculate recently the cost of materials in a crib-pier, or breakwater, of the ordinary form, *i. e.*, comprising grillage bottoms with pine-top courses for the cribs and resting on a rubble-stone foundation, and it being desirable to determine the most economic proportioning of the depths of foundations and cribs, the results of the calculations have proved both interesting and useful. I am not aware that the same method has been used elsewhere in the numerous similar structures where it could be applied, and I have the honor therefore to submit the results of my calculations.

To make the problem of general application, the following diagram is taken to represent the cross-section of any crib and its foundation, and the following notation has also been adopted:



Let a = the desired or economic width of crib
Let b = the width of the bermes of the foundation.
Let c = the cost of one hemlock course and its stone filling above grillage.
Let c^1 = the cost of one cubic foot of rubble-stone for the foundation and for filling, in dollars.
Let l = the length of crib; d, the depth of water; x, the depth of the foundation, and y, the depth of the crib, all in feet.

From the relation of the parts it at once follows, that $x + y = d$; $a + 2b$ = width of top of the foundation, and $a + 2b + 2x$ = width of the base of the foundation; also, that $\frac{(a+2b)+(a+2b+2x)}{2} x$ = area of cross-section of the foundation $= a x + 2b x + x^2$; and multiplying this by the length of a crib and the cost of a cubic foot of rubble-stone, we have: Eq. (A); $(a x + 2b x + x^2)\, l\, c^1$ = cost of foundation for one crib, in dollars.

Whatever height the crib may have, its grillage bottom and pine top, usually two courses for each, with their stone filling, will remain a constant part of its entire cost; depending only on the form of construction; and the only portion of the cost that will be variable will depend on the number and cost of the intermediate hemlock courses, or $(y - 4)\, c$.

Denoting the aggregate cost of the grillage bottom and pine courses with their stone filling by large C and we have Eq. (B); $(y - 4)\, c + C$ = cost of one crib and stone filling of a height y.

Adding equations A and B there results, $(y - 4)\, c + C + (ax + 2bx + x^2)\, l\, c^1$ = total cost of crib and foundation of a length l.

The problem consists in finding values for x and y that will make the second term, total cost, a minimum. To do this, first eliminate y from the last equation by

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substituting its value, $y = d - x$, and the equation at once becomes $(d - x - 4)\,c + C + (ax + 2bx + x^2)\,l\,c^1$ = total cost of crib and foundation of length l. Differentiating and placing the first differential coefficient $= O$ we have, $-c\,.\,dx + (a\,.\,dx + 2b\,.\,dx + 2x\,dx)\,l\,c^1$ = differential of the total cost, and, $-c + (a + 2b + 2x)\,l\,c^1 = O$, or,

$$x = \frac{c}{2l\,c^1} - \frac{a + 2b}{2}.$$

It follows, therefore, that in every case the best height to give the foundation, as far as economy of construction alone is concerned, can always be found by this rule:

"Ascertain the cost of one of the hemlock courses above the grillage bottom, with its stone filling, divide this by the product of twice the length of the crib and the cost of a cubic foot of the rubble-stone, in dollars, and subtract from the quotient one-half the width of the top of the foundation."

The verifying of this simple rule in any case of actual construction is both interesting and curious. In the breakwater at Burlington, Vt., for instance, the assumed economic width of crib was placed at 22 feet, its length 40 feet, width of bermes 6 feet, and the average depth of water is 32 feet. The cost of a cubic foot of stone (last year's prices) is 3 cents, and as the cribs were designed to have two interior longitudinal and four cross-walls, of alternating courses, and the cost of hemlock last year was $25 per M feet, B. M., and cost of drift-bolts 6 cents per pound, the cost of one hemlock course and stone filling would be $85.47. Applying the equation, or rule, we have $x = \frac{85.47}{80 \times \frac{3}{100}} - 17 = 35 - 17 = 18$ feet, and it follows that the most economic height of the foundation is 18 feet, and that the crib should be 14 feet deep; also, that the width of crib and the same form of construction will not allow a change of a single foot in the depths of the crib and foundation in either direction without an increase of cost, which may easily be verified by actual estimate. Furthermore, that this will amount to about $7.50 per linear foot of the structure if cribs 22 feet wide only were carried to the bottom, and to $3.50 per linear foot if the foundation was to be carried to the surface of the water.

Of course there are always other conditions depending upon the location, such as the degree of wave disturbance, draught of vessels, etc., which must not be overlooked in determining the height of the foundation; but in most of the works of this character an application of the rule would show that limit towards which the foundation should tend, the other considerations being accorded their due weight.

The principle involved in this method of investigation could be still further extended; for instance, under one of the usual conditions of crib construction, that the width shall be the same as the depth of water, the width of crib may be introduced as a variable in the calculation; however, the expression for its most economic depth and width becomes too complicated under such circumstances for ready application and it assumes a value which can only be expressed conveniently in algebraic language.

In so far as estimates on crib-work and foundations are concerned, since the cost of timber is usually the same for all lengths up to 24 feet, any width within that limit may be assumed for the crib, and if the first application of the rule gives rise to any incongruity, such as a too great width of crib for its depth, resulting from the calculated economic depth of foundation, or the foundation coming too high for stability under the action of the waves, or again so as to endanger vessels alongside the structure, then a second application of the rule, based on a new assumed width and a new calculated cost of one of the hemlock courses and filling, would usually eliminate the incongruity, and result in as economic a structure as could be built of the form selected.

The problem of providing a stable structure in extension of the breakwater at Burlington, Vt., also involves a consideration of ice thrust and a form of structure to meet it. This has been done in the plan herewith submitted, by giving the exterior face of the crib and superstructure a slope of 45 degrees from 2 feet below low water to the crest, and a simple but secure method of framing the timbers of the sloping wall to the cross-ties has been devised, all of which would seem to afford entire security in the event of a movement of ice occurring against the breakwater.

The plan herewith contemplates, therefore, that the structure should consist of a stone foundation 70 feet wide at base, 34 feet wide on top, and 18 feet deep, which will bring the top of the foundation 14 feet below extreme low water. On this foundation cribs of hemlock timber should rest, being 22 feet wide and 40 feet long and having the usual grillage bottoms and pine tops; only the outer wall, for 2 feet at its top, is to be drawn in on a slope of 1 on 1; this is to have a continuous superstructure, the inner and interior walls being formed as usual, except that the latter are to be formed of 6 by 10 inch timbers, and the outer wall is to be composed of 8¼ by 8¼ inch timbers, setting on edge, so as to form a continuous wall, inclined at an angle of 45 degrees and measuring 12 inches thick horizontally.

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Such a structure would cost $74.20 per running foot, as compared with $97.60 per running foot for the structure heretofore built in the same depth of water and at the same cost for materials, a saving of 24 per cent. on the former cost.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. C. E. Blunt, Corps of Engineers, U. S. A.)

The work of actual construction at this harbor during the past year was limited to some slight repairs that were made to the northern end of the breakwater, so as to bring 300 linear feet of that end of the structure above ordinary high-water level. Such was the delay attending the examination of the plans, specifications, etc., for the modification in the scheme for further extensions of the breakwater, that the first work to be done under this modified scheme could not be advertised until just before the close of the fiscal year.

It is expected that the usual satisfactory responses will be received in answer to the advertisements, and that the available funds will be pledged, under contract, for the construction of 240 linear feet of extension to the southern end of the breakwater in July; also, that operations will be commenced in July or very soon thereafter.

As additional funds become available for this improvement it is expected they will be applied in further extensions to the breakwater, so as to keep pace with the growth of the commerce and the extensions of the line of docks and wharves of the harbor, and in maintenance.

Money statement.

July 1, 1886, amount available	$3,202.31
Amount appropriated by act approved August 5, 1886	18,750.00
	21,952.31
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	1,382.07
July 1, 1887, amount available	20,570.24

Amount (estimated) required for completion of extisting project	184,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

Name of harbor, Burlington, Vt.; collection district, Vermont; nearest light-house, Juniper Island.

Statement of importations by water, from Canada, at the port of Burlington, Vt., during the season of navigation, 1886.

Articles.	Quantity.	Value.
Pine and spruce.....feet..	41,187,386	$497,612
Hemlock and bass.....do...	902,430	6,008
Lath.....pieces..	9,080,100	11,204
Pine and cedar shingles.....M..	3,628	6,658
Pickets.....pieces..	3,675,614	32,404
Total.....	.....	553,886

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Number and tonnage of vessels which entered and cleared at the custom-house, port of Burlington, Vt., during the year 1886.

Vessels.	Entered from Canada.		Cleared for Canada.		Coastwise clearances.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
American	47	4,889	13	1,254		
Foreign	208	26,523	183	23,566	14	1,613
Total	255	31,412	193	24,820	14	1,613

The above was received through the kindness of the collector of customs.

OO 8.

IMPROVEMENT OF OTTER CREEK, VERMONT.

The project for this improvement was adopted in 1872, and, as modified in 1882 and 1884, proposes the formation of a channel from Vergennes, Vt., to Lake Champlain, of a navigable width, and to afford a least depth of 8 feet. (See Reports of Chief of Engineers, 1872, page 273; 1882, page 712; and 1884, page 2159.)

The last operations under the above head consisted in the dredging of some 11,773 cubic yards of obstructing material from Bull Brook Bend and its vicinity in 1884, whereby much benefit was done the general navigation of the channel and the improvement of this obstruction, which had been the most serious on Otter Creek, was perfected.

In order to complete the scheme of improvement, the channels at Sharkie's and Crittenden's bends, at Steamboat Landing and at the mouth of the creek, should all receive attention, as contemplated in the original and modified projects.

Money statement.

July 1, 1886, amount available	$648.34
July 1, 1887, amount available	648.34
Amount (estimated) required for completion of existing project	39,748.00
Amount that can be profitably expended in fiscal year ended June 30, 1889. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	5,000.00

COMMERCIAL STATISTICS.

The collector of customs was unable to give any statement in regard to Otter Creek, and the latest information obtainable with regard to its commerce is that in the Report of the Chief of Engineers for 1879, as follows:

COMMERCE OF OTTER CREEK DURING THE YEAR ENDING JUNE 30, 1879.

Coal	tons..	3,000
Kaolin	do...	1,500
Timber	feet..	4,000,000
Brick	number..	100,000
Potatoes	bushels..	4,000
Merchandise	tons..	500

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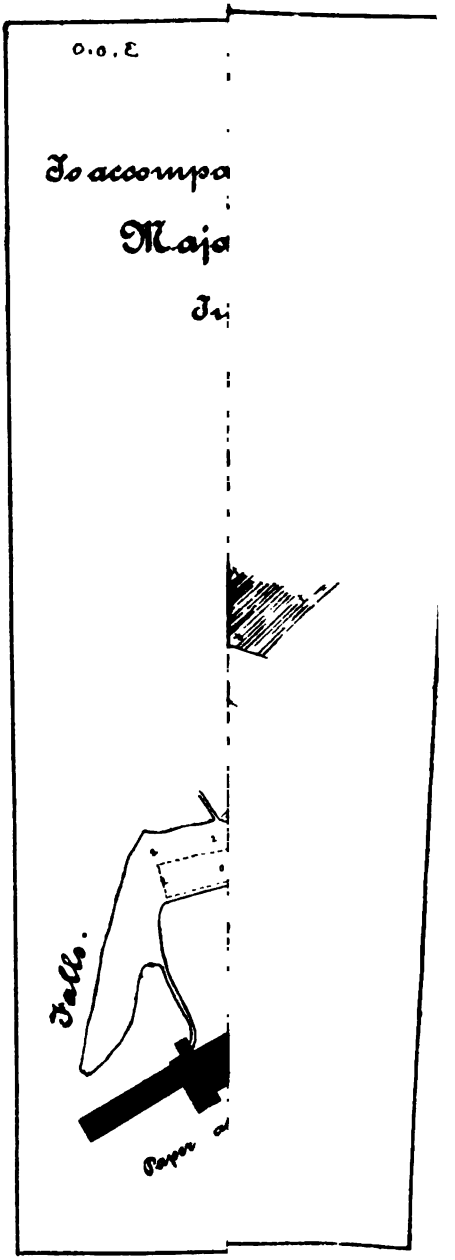

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OO 9.

IMPROVEMENT OF TICONDEROGA RIVER, NEW YORK.

The project for this improvement was adopted in 1881, its object being the formation of a channel of navigable width and a least depth of 8 feet at low water between the falls at Ticonderoga village and Lake Champlain, a distance of about 2 miles. (See Report of Chief of Engineers, 1881, page 726.) The improvement was estimated to cost $42,516, of which amount $12,000 have been appropriated.

There have been no operations during the fiscal year. The amount appropriated by act approved August 5, 1886, $2,000, has been pledged under contract dated March 9, 1887; and it is expected that work as comprehended in the contract, being the removal of 10,000 cubic yards from the channel, will soon be commenced and finished, which will practically exhaust the available funds.

In order to fully carry out the scheme of improvement, the channel that will be afforded with the completion of the existing contract ought to be very generally deepened, so as to afford an 8-foot draught instead of a 6-foot draught, since operations have thus far been directed towards the securing of the lesser depth, as the first step in the improvement.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	135.40
July 1, 1887, amount available	1,864.60
Amount (estimated) required for completion of existing project	30,516.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS FOR THE PORT OF TICONDEROGA, NEW YORK, FOR THE CALENDAR YEARS 1881 AND 1886.

Freight received in 1881, 38,000 tons; in 1886, 55,000 tons.

The collector of customs for the district of Champlain reports that the above was obtained from the postmaster at Ticonderoga and from Mr. M. B. Burleigh. He also reports that the "presidents of Ticonderoga declare that the improvements to Ticonderoga River keep down the rates of freight, etc."

OO 10.

IMPROVEMENT OF NARROWS AT LAKE CHAMPLAIN, NEW YORK AND VERMONT.

The project for this improvement was adopted in 1885, and has for its object the removal of such obstructions in the channel between Whitehall, N. Y., and Benson Landing, Vt., as will afford a least depth of 12 feet and a least width of 150 feet. The entire undertaking was estimated to cost $86,000. There were $30,000 appropriated for the work by act approved August 5, 1886. The most important portions of the improvement were duly advertised September 21, 1886, and the

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removal of the rock-reef near the "Elbow," about a mile below Whitehall, and 100,000 cubic yards of dredging in Kinyon's Bay, were contracted for; with the lowest bidders for each being Luther Whitney and John L. Johnson respectively, the corresponding dates of contracts being October 21 and October 18, 1886.

Work under both contracts is well advanced; that of rock excavation about completed, in fact; and it is expected the other will be completed within the specified time, which will practically exhaust the appropriation at the close of the present working season, November 30, 1887.

As additional funds become available it is expected they will be applied to the further widening and deepening of the channel, within the limits comprehended in the scheme of improvement, by dredging. If any modification in the plan of improvement is recommended, it is now thought it will be to confine operations at Four Channels to dredging without closing the cross-channel there.

Money statement.

Amount appropriated by act approved August 5, 1886		$30,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,084.56	
July 1, 1887, outstanding liabilities	56.50	
		3,141.06
July 1, 1887, amount available		26,858.94
Amount (estimated) required for completion of existing project		56,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		56,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Statement of commerce and navigation for the port of Whitehall, N. Y., for the calendar year 1886.

	Canal-boats, barges, etc.	
	No.	*Tons.*
Arrived	3,240	324,000
Departed	3,240	324,000

Estimated value of cargoes:	
Arrived	$2,092,000
Departed	250,000

OO 11.

EXAMINATION AND SURVEY OF "THE GUT," LAKE CHAMPLAIN, VERMONT.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., December 16, 1886.

GENERAL: In accordance with letter of Hon. George F. Edmunds to the Secretary of War, dated November 6, 1886, requesting a survey and report to be made as to the expediency of improving "The Gut," a narrow channel between North and South Hero islands, in Lake Cham-

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plain, which was approved by the Secretary of War in an indorsement dated November 23, and referred to me with your letter dated December 1, 1886, I have the honor to inclose a report by Assistant Engineer John C. Churchill, jr., of an examination of said narrow channel, made by him under my instructions.

The report of Mr. Churchill is concurred in by me, except that the estimate of cost for the removal of 12,000 cubic yards, consisting mainly of bowlders at the west end of the Gut Channel, should, I think, be placed at $12,000 and 10 per cent. for contingencies, or, say, $13,200, making the entire estimate $14,300, instead of $10,175.

I would also state that the reasons that have caused 10 feet to be assumed as the depth to be attained in this improvement, when 12 feet is the usual depth in other improved channels in this lake, are that a hard pan or soft flat rock would be encountered at a greater depth here, and the channel would require deepening throughout its entire length if the depth was made greater than 10 feet.

Previous papers in relation to this subject are herewith inclosed.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., December 16, 1886.

MAJOR: I have the honor to submit herewith my report of a survey of the channel between North and South Hero islands, Lake Champlain, Vermont, known as "The Gut," made under your instructions.

"The Gut" is the main channel between ports on Lake Champlain west and south of North and South Hero islands and the large body of water lying between those islands and the Vermont mainland, including Macquam Bay and St. Albans Bay.

Communication with this latter portion of the lake is cut off at the south by the sand-bar bridge. "The Gut," therefore, is a very important channel. It is about 2 miles long, and the channel throughout it varies in width from 40 feet at the west and 100 feet at the east entrance to three-quarters of a mile at the middle.

At each end of "The Gut" a bar extends from island to island, and it is the portion of the channel through these bars which requires improvement to make it safe for navigation, the remainder having a depth of 10 feet, sufficient for the needs of commerce in this part of the lake.

There is no permanent current through this passage, but only such as is caused by high winds.

While this survey was in progress a heavy southwest squall occurred, after which a current set out of "The Gut" to the west with an estimated velocity of 2,500 feet per hour.

These currents and the west and southwest winds at the west entrance, and northeast winds at the east entrance, make the navigation of these narrow channels both difficult and dangerous.

The effect of this is to cause many vessels from the upper lake, especially tow-boats, to make a detour around the foot of North Hero Island in order to reach Macquam and St. Albans bays, increasing the distance 3 miles to the first and 20 miles to the second.

I learn from the captain of the steamer *Macquam* that 26,000 tons of freight were thus necessarily carried by that steamer to Macquam Bay during the season of 1885 through this north channel instead of through "The Gut," on account of the danger in using the latter channel.

The bar at the west entrance is composed of heavy bowlders, gravel, and clay. The channel through it is 40 feet wide, and has a governing depth of 7 feet. On the side of this channel are also a number of stones, which were formerly anchors for light-house buoys. Ice carried away the buoys, and the stones, are left in positions very dangerous to navigation, they being heavy and having sharp corners and edges.

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One of these lies directly in the channel, as now indicated by the buoys, and has but 7 feet of water over it. The steamer *Macquam* has twice struck rocks in this channel and been badly injured.

I would respectfully recommend that the channel through this bar be made 150 feet wide and 10 feet deep at low water.

Such a channel would be about 800 feet long, and would necessitate the removal of about 12,000 cubic yards of material, with classification, and at a cost approximately as follows:

Removing 7,000 cubic yards of rock, bowlders, and heavy gravel, at $1 per cubic yard	$7,000
Removing 5,000 cubic yards clay and small gravel, at 25 cents per cubic yard.	1,250
10 per cent. for contingencies	825
Total cost	9,075

This improvement would, I believe, be permanent in its character, the materials of which the bar is composed being such that very little filling would ever take place.

The bar at the east entrance to "The gut" is composed of small gravel and clay, with a few bowlders.

The channel through it is 100 feet wide, with a least depth of 8 feet.

This channel, on account of its greater depth and width, is not so dangerous as that at the west entrance.

It would be greatly improved, however, by straightening and giving it a uniform width and depth with that proposed for the west entrance, viz, 150 feet width and 10 feet depth at low water.

This would necessitate the removal of about 4,000 cubic yards of clay and gravel, costing, approximately, as follows:

Removing 4,000 cubic yards of clay and gravel, at 25 cents per cubic yard	$1,000
10 per cent. for contingencies	100
Total	1,100

The total estimated cost of improving the channel through "The gut" will be, therefore:

Improving west entrance	$9,075
Improving east entrance	1,100
Total cost of improvement	10,175

It is impossible to get full commercial statistics of this channel, as no record is kept of vessels passing through it. It is used both by steam and sail craft. The steamer *Macquam* carried through it about 5,000 tons of freight during the season of 1885.

If the improvement recommended is made "The gut" will be used by two boats plying between Macquam and St. Albans Bays, and ports west and south of the islands, and a great aid will be given to the commerce of this part of Lake Champlain.

Respectfully submitted.

JOHN C. CHURCHILL, Jr.,
Assistant Engineer.

Maj. M. B. ADAMS,
Corps of Engineers, U. S. A.

OO 12.

PRELIMINARY EXAMINATION OF WADDINGTON HARBOR, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., November 24, 1886.

GENERAL: In compliance with your instructions communicated in circular letters dated September 27 and October 28, 1886, and as required by section 6 of river and harbor act approved August 5, 1886, I have the honor to transmit herewith a report, by Assistant Engineer John C. Churchill, jr., on a preliminary examination made of Waddington Harbor, New York, with a view to determining whether it is advisable to improve that harbor.

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His report sets forth fully and particularly the reasons on which he bases the opinion that, at most, the only feature in which this harbor is regarded as worthy of improvement is that of dredging 6,000 cubic yards of mud, sawdust, etc., from between the foot of Ogden Island and the ferry dock, where dredging was done in 1875, but that has now become somewhat obstructed in consequence of an accident to the dam above allowing a quantity of such material to pass below and find lodgment there.

I concur in the views expressed in Mr. Churchill's report, that it would not be advisable to undertake any general improvement of this harbor, the requirements of its commerce rendering such an outlay injudicious.

Very respectfully, your obedient servant,

M. B. ADAMS,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S, A.

MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., November 15, 1886.

MAJOR: I have the honor to submit herewith the following report of an examination of Waddington Harbor, New York, made under your instructions on the 2d and 3d of this month. Waddington is situated on the St. Lawrence River, 18 miles below Ogdensburgh, and is a village of about 1,000 inhabitants. Ogden's Island is opposite the town and extends about 2 miles above and 1 mile below it, and is separated from the American shore by Little River, a stream which is from one-eighth to a quarter of a mile wide.

To the north of Ogden's Island is the Rapids plat of the St. Lawrence River, around which a canal has been built by the Canadian Government, which canal is used by vessels ascending the river. The village was founded by the Ogden family, who early in the century owned the island. They built a dam across Little River and so furnished water-power for the mills and manufacturing establishments which are situated upon and below the dam. They also built a bridge about 900 feet above the dam, which was originally partly of cribs and partly solid, having spaces through which water could pass or be shut off according to the demands at the dam. There is now but one opening of 35 feet left in the bridge, and it is intended next spring to put in a draw-bridge here and so give communication from the upper part of Little River to the dam.

The commerce between Waddington and other ports is carried on almost exclusively by boats drawing no more than 7 feet of water.

During the fiscal year ending June 30, 1886, no boat of more than 36 tons entered or cleared. A steam freight-boat makes regular trips during the season between Ogdensburgh and Waddington, and a steam ferry-boat plies daily between Waddington and Morrisburgh, Canada.

For convenience of this report, Waddington Harbor may be divided as follows:

(1) From the head of Ogden's Island to the dam.

(2) From the foot of Ogden's Island to the ferry dock, which is about 1,000 feet below the dam.

(3) From the ferry dock to the dam.

(1) *From the head of Ogden's Island to the dam.*—In 1874 and 1875 a channel was dredged through the bar at the head of Ogden's Island, and a depth of 10 to 12 feet made through it.

From soundings taken in the channel, I found a least depth of 12 feet, showing that it has retained the depth made.

From this bar there exists, and has for many years existed, a channel to the bridge from 300 to 600 feet wide and from 10 to 15 feet deep, making a continuous channel, amply deep for the present needs of commerce, from the St. Lawrence River to the bridge, which is the present limit of navigation in this direction.

From the bridge to the dam there is a channel with a least depth of 8 feet, which will accommodate all commerce likely to reach the dam.

(2) *From the foot of Ogden's Island to the ferry dock.*—During the fall of 1874 and the summer of 1875 a channel was dredged from deep water below the ferry dock to that dock.

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From the foot of Ogden's Island to within 200 feet of the ferry dock I found the channel to be in good condition, having a least depth of 10 feet, but from the point above mentioned to the ferry dock I found the channel filled from 2 to 3 feet with mud and sawdust. This material was deposited there last spring, when 160 feet of the south end of the dam gave way, the flood carrying mud and sawdust to this point. To rectify this will require the dredging of a channel 250 feet long by 200 feet wide to a depth of 10 feet, necessitating the removal of about 6,000 cubic yards, scow measurement, of soft material, at a cost as follows:

Dredging 6,000 cubic yards mud and sawdust, at 25 cents per yard	$1,500
Add 10 per cent. for contingencies	150
Total	1,650

(3) *From the ferry dock to the dam.*—In 1875 a channel was dredged from the ferry dock to the dock near the mills on the dam, making a least depth of 3½ feet, the depth being limited by rock.

During the summer of 1881 work was commenced on this same channel with a view to deepening it by excavating the rock. An area, 160 feet long by 50 wide, was broken up, but the loose rock was not removed, as the appropriation gave out. This work did not improve the depth of the water in the channel, but still left it with a governing depth of 3½ feet.

There is also a channel next the island up to the dock line at the dam from 60 to 100 feet wide with a depth of from 6 to 14 feet. This channel might be used in case boats drawing more than 3½ feet of water wished to approach the dam.

At the time of the examination there was no indication that either of those channels was used or had been for some months at least.

At the dam there is a grist-mill and a furniture manufactory which are running, two saw-mills and a carding-mill not running.

These mills all run some part of the year, but have been doing very little this season on account of the break in the dam, mentioned before, and which was repaired only last month.

It does not appear that any of these mills need further harbor facilities than they already have.

Many of the people of Waddington are very anxious that a lock should be built at the dam which would allow boats to pass it. A survey and estimate with this object in view was made under the direction of Col. John M. Wilson, in 1875, but the execution of the project was not recommended at that time. There is less need for such a lock now.

Waddington is a port of entry in the collection district of Oswegatchie. The nearest American light-house is at Ogdensburgh, and Fort Montgomery, 100 miles distant, is the nearest work of defense.

A comparison of the custom-house reports of the last fiscal year, with those of 1882 and 1883, is made herewith:

Year.	Revenue from customs.	Value of imports.	Value of exports.	Number of vessels cleared.	Number of vessels entered.
1882	$12,638.87	$67,800.00	$9,000.00	20	20
1883	15,121.60	73,562.00	(*)	(*)	(*)
1885	7,836.76	47,874.00	862.00	19	23

*Not given.

Very respectfully,

JOHN C. CHURCHILL, Jr.,
Assistant Engineer.

Maj. M. B. ADAMS,
Corps of Engineers, U. S. A.

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APPENDIX P P.

ANNUAL WATER-LEVEL CURVES OF THE NORTHERN AND NORTHWESTERN LAKES.

Tri-daily observations of water-gauges were made at Charlotte and Sackett's Harbor, N. Y., on Lake Ontario, from July, 1882, to June 30, 1883, and continued at Charlotte from July, 1883, to June 30, 1887. The zero of the gauge at Charlotte was lowered 4.5 feet by Lieut. Col. I. M. Robert, Corps of Engineers, in May, 1883, and is now at 4.98 feet below the plane of reference of the lake.

Observations were also made at Erie Harbor, Pa., and at Cleveland Harbor, Ohio, on Lake Erie, from July, 1882, to June 30, 1887; at Milwaukee, Wis., on Lake Michigan, from July, 1882, to June 30, 1887, and daily observations at Escanaba, Mich., on Green Bay, Lake Michigan, from July, 1882, to June 30, 1887. At the last-named place observations were not made in January, February, March, and April in the years 1883, 1885, and 1887, nor in January, February, and March, in 1884 and 1886, by reason of ice and snow. Capt. W. L. Marshall, Corps of Engineers, in his letter of October 1, 1887, states:

In former reports the zero of Escanaba gauge has been assumed as 0.76 foot above the plane of reference, but a comparison of corrected readings at Milwaukee and Escanaba show that the determinations of the plane of reference at Milwaukee and Escanaba vary 0.187 foot, the Escanaba plane being too high or the Milwaukee determination too low.

The reported readings for Escanaba have been further reduced 0.187 foot to compare with Milwaukee.

Daily observations were made at Sand Beach, Lake Huron, from September, 1874, to June 30, 1887, and at Sault Ste. Marie from December, 1881, to May 30, 1887, and at Marquette, Mich., on Lake Superior, from July, 1882, to June 30, 1887.

The accompanying plates are continuations of those published in the Annual Report of the Chief of Engineers for 1882, Part III, page 2820.

Monthly mean of water-level at Sand Beach, Lake Huron, from September, 1874, to June 30, 1881, in feet, below the plane of reference adopted in 1876. (See plate.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
.....	.....	.....	.....	.....	.....	.....	.....	.....	2.74	3.01	3.55	3.40
.....	3.09	3.75	3.71	3.52	3.17	2.86	2.67	2.70	2.66	2.85	2.96	3.23
.....	3.11	3.13	3.00	2.72	2.12	1.63	1.19	1.25	1.36	1.76	1.91	2.10
.....	2.39	2.40	2.47	2.39	2.22	2.26	2.08	2.18	2.45	2.59	2.64	2.69
.....	2.79	2.96	2.79	2.86	2.46	2.29	2.25	2.35	2.64	2.63	2.82	3.02
.....	3.32	3.56	3.60	3.57	3.44	3.30	3.26	3.39	3.47	3.71	3.83	3.85
.....	3.80	3.86	3.87	3.86	3.46	2.97	2.66	2.77	2.88	3.24	3.36	3.56
.....	3.69	3.30	3.29	3.27	2.95	2.78	.....	.....	.....	.....	.....	.....

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Monthly mean of water-levels for the several stations, in feet, below the planes of reference adopted in 1876. (See plates.)

Stations.	1881.						1882.					
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Sand Beach	2.63	2.80	2.96	2.71	2.58	2.75	2.90	3.13	2.99	2.77	2.60	2.37
Sault Ste. Marie	.....	.....	.....	.....	.....	2.81	3.29	3.49	3.59	3.63	3.24	3.14

	1882.						1883.					
Charlotte	1.35	1.72	2.10	2.57	3.05	3.36	3.59	3.52	3.30	2.74	2.12	1.51
Sackett's Harbor	1.36	1.66	2.14	2.60	3.04	3.27	3.47	3.52	3.40	2.82	2.18	1.51
Erie	0.92	1.15	1.50	1.78	2.15	2.23	2.48	2.30	2.21	2.16	1.69	0.91
Cleveland	1.05	1.19	1.46	1.91	2.23	2.74	2.83	2.62	2.43	2.31	1.85	1.15
Milwaukee	2.109	1.919	2.043	2.448	2.662	2.993	3.250	3.210	3.122	2.910	2.427	2.065
Escanaba	2.013	2.073	1.973	2.203	2.513	3.203	.....	.....	.....	.....	2.483	2.257
Sand Beach	2.23	2.17	2.29	2.52	2.77	2.92	3.12	3.17	3.13	3.12	2.55	2.13
Marquette	2.85	2.73	2.69	2.86	2.88	3.07	3.30	3.59	3.59	3.34	3.33	3.23
Sault Ste. Marie	2.80	2.71	2.79	2.86	2.92	3.21	3.61	3.72	3.70	3.64	3.63	3.29

	1883.						1884.					
Charlotte	1.28	1.436	1.867	2.29	2.55	2.64	2.70	2.28	2.19	1.11	0.97	1.075
Erie	0.70	0.91	1.36	1.57	1.50	1.66	1.90	1.97	1.70	1.20	0.93	0.97
Cleveland	0.95	1.01	1.32	1.64	2.02	1.99	2.32	2.06	1.87	1.32	1.05	0.97
Milwaukee	1.469	1.504	1.692	1.905	2.362	2.439	2.655	2.544	2.293	2.113	1.898	1.743
Escanaba	1.693	1.583	1.843	2.053	2.293	2.343	.....	.....	.....	2.123	1.953	1.843
Sand Beach	1.65	1.45	1.77	2.10	1.99	2.10	2.29	2.44	2.40	2.09	1.87	1.81
Marquette	2.98	2.965	2.997	3.20	3.35	3.464	.....	.....	.....	3.957	3.744	3.541
Sault Ste. Marie	3.09	2.74	3.02	3.18	3.33	3.53	3.65	3.68	3.80	4.08	3.61	3.62

	1884.						1885.					
Charlotte	1.219	1.479	1.976	2.38	2.98	3.044	3.067	3.36	3.58	2.851	2.06	1.723
Erie	0.90	1.05	1.48	1.74	2.02	2.16	2.37	2.75	2.92	2.12	1.37	0.89
Cleveland	1.19	1.35	1.78	2.11	2.59	2.66	2.84	3.05	3.19	2.37	1.64	1.13
Milwaukee	1.899	2.042	2.294	2.288	2.648	2.679	2.672	2.444	2.476	2.287	1.927	1.723
Escanaba	1.839	1.932	2.029	2.119	2.538	2.693	.....	.....	.....	.....	1.900	1.785
Sand Beach	1.73	1.85	2.20	2.04	2.39	2.65	2.38	2.47	2.47	2.36	1.96	1.67
Marquette	3.405	3.390	3.119	2.770	2.863	3.067	3.297	3.480	3.557	3.608	3.333	3.005
Sault Ste. Marie	3.38	3.34	3.28	3.19	3.14	3.33	3.54	3.63	3.76	3.94	3.39	3.02

	1885.						1886.					
Charlotte	1.58	1.77	1.96	2.87	2.84	2.27	1.94	1.94	1.94	0.97	0.81	0.88
Erie	0.90	0.90	1.00	1.20	1.11	1.00	1.20	1.90	2.30	1.50	1.00	0.90
Cleveland	1.17	1.16	1.31	1.41	1.53	1.58	1.56	2.29	2.48	1.60	1.30	1.20
Milwaukee	1.633	1.424	1.559	1.703	1.999	2.288	2.057	2.044	1.757	1.490	1.230	1.159
Escanaba	1.603	1.613	1.599	1.777	2.055	1.930	.....	.....	.....	1.513	1.273	1.297
Sand Beach	1.61	1.46	1.56	1.79	1.98	2.18	2.18	2.11	1.92	1.63	1.30	1.21
Marquette	2.757	2.655	2.708	2.894	3.033	3.362	3.560	3.691	3.751	3.655	3.414	3.273
Sault Ste. Marie	2.84	2.63	2.88	3.03	3.11	3.41	3.75	3.92	3.92	3.94	3.46	3.30

	1886.						1887.					
Charlotte	1.21	1.63	2.05	2.41	2.70	2.78	2.98	2.30	1.86	1.58	1.05	1.06
Erie	1.42	1.56	1.86	2.04	2.17	2.25	2.40	1.86	1.50	1.51	1.35	1.19
Cleveland	1.22	1.42	1.67	1.90	2.19	2.27	2.50	2.07	1.29	1.24	1.06	1.04
Milwaukee	1.349	1.581	1.822	1.916	2.261	2.589	2.672	2.304	2.143	2.187	1.993	1.863
Escanaba	1.478	1.577	1.622	1.879	2.313	2.522	.....	.....	.....	.....	1.923	1.867
Sand Beach	1.37	1.52	1.70	1.83	2.10	2.42	2.55	2.40	2.19	2.28	2.08	1.96
Marquette	3.204	3.294	3.312	3.207	3.360	3.497	3.801	3.777	3.473	3.305	3.512	3.348
Sault Ste. Marie	3.11	2.96	3.13	3.15	3.16	3.57	3.82	3.92	3.99	4.12	3.76	.....

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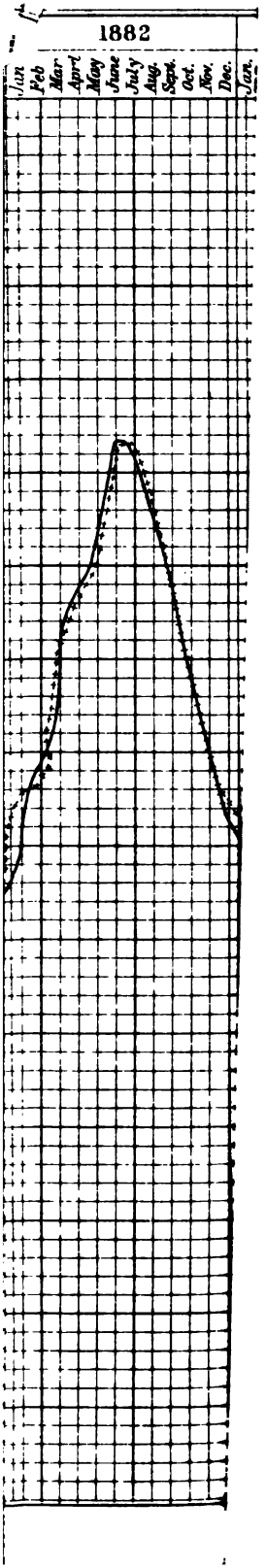

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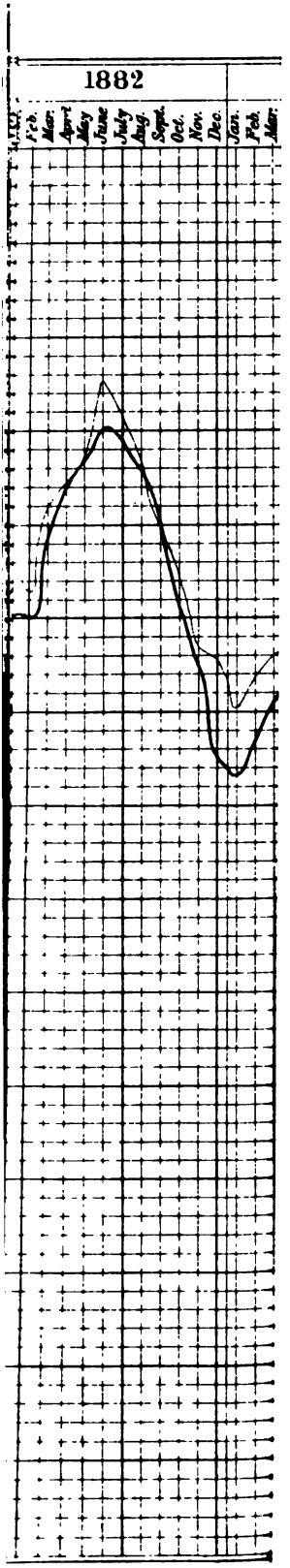

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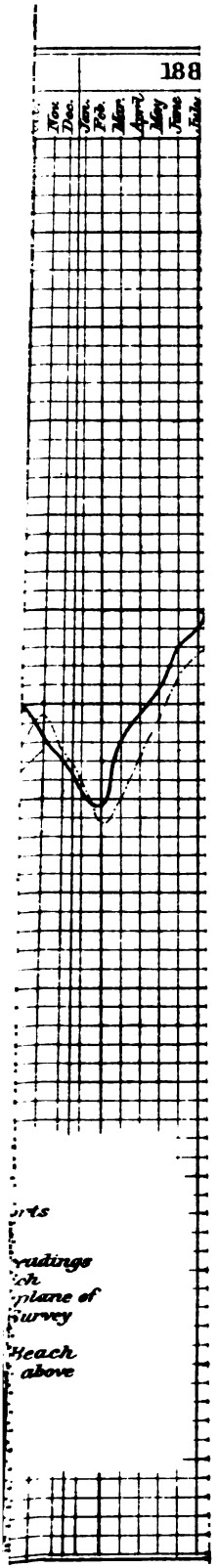

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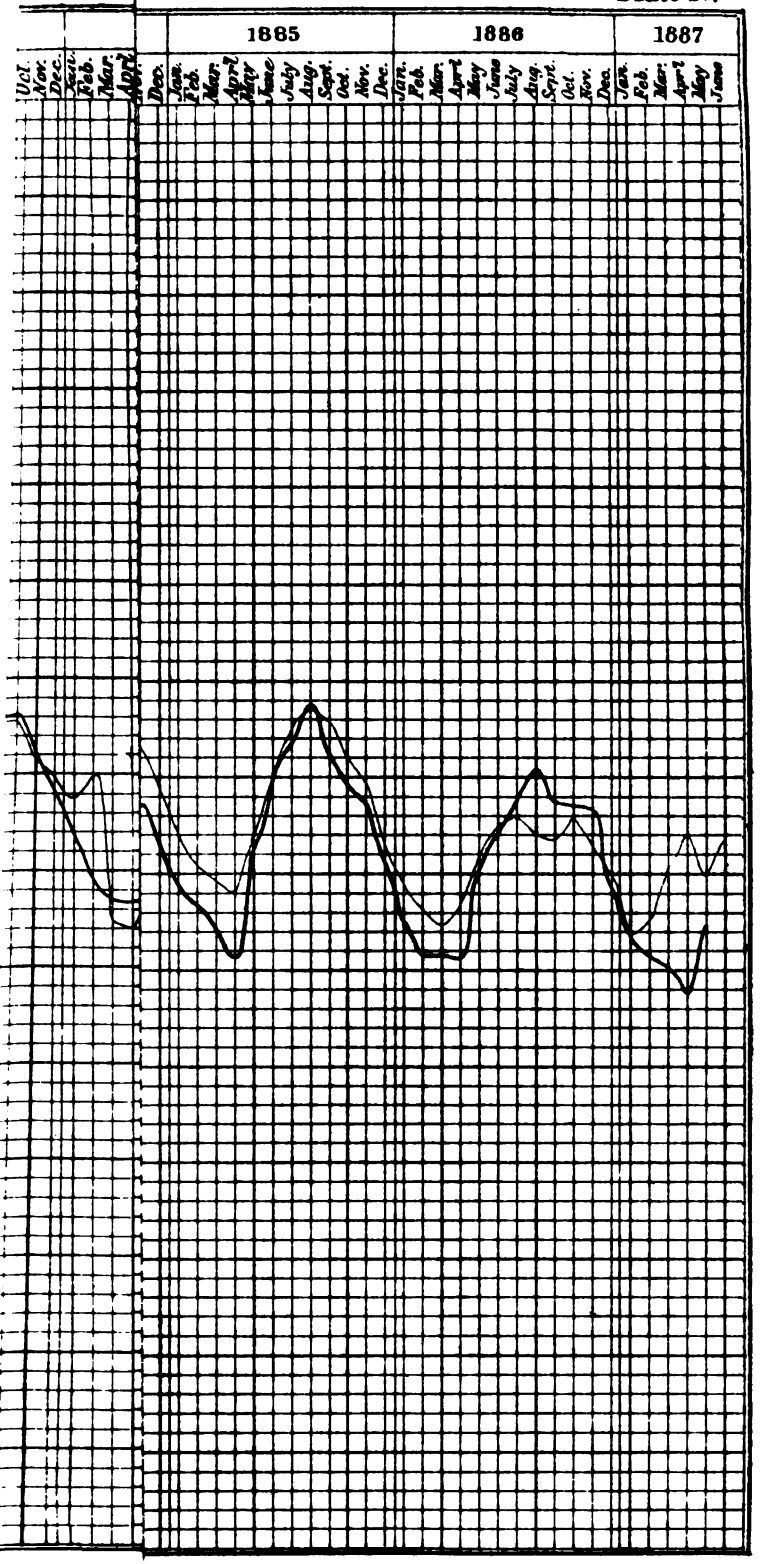
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APPENDIX Q Q.

IMPROVEMENT OF THE HARBORS OF OAKLAND AND REDWOOD, CALIFORNIA.

REPORT OF COLONEL G. H. MENDELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Oakland Harbor, California.
2. Redwood Harbor, California.
3. San Francisco Harbor, San Pablo and Suisun bays, Straigts of Carquinez, and mouths of Sacramento and San Joaquin rivers.
4. Removing sunken vessels obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 26, 1887.

SIR: I have the honor to inclose annual reports for the year ending June 30, 1887, on account of river and harbor works under my charge.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

Q Q 1.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

STATEMENT OF PROJECT.

The project for this improvement is intended to secure a depth of 18 to 20 feet at low water. The natural depth at the entrance was about 2 feet. The means for securing the improvement consist in two stone jetties extended from the shore to deep water in San Francisco Bay; in dredging between the jetties and increasing the tidal prism of the harbor by excavation of the tidal basin, and by connection of this harbor with the adjoining basin of San Leandro by means of a canal.

The jetties have been extended as follows, viz:

	Feet.
North jetty	9,203
South jetty	11,868

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The jetties are not completed, but they answer for the present amount of tidal volume.

The channel between the jetties has been dredged to a width of 300 feet, and middle depth of low water of 14 feet, and side depths of 10 feet.

Nearly two-thirds of the amount of dredging proposed for the tidal basin has been completed.

No work has been done on the connecting canal with San Leandro, but the land has been paid for.

A channel 100 feet wide has been dredged to a depth of 14 feet in front of the city of Oakland.

Some departures from the original project, rendered necessary by circumstances occurring after the preparation of the project, were noted in the last annual report.

OPERATIONS OF THE PAST YEAR.

A contract for dredging the tidal basin was made with Von Schmidt & McNee on October 27, 1886. The work was begun on December 13, 1886, and the contract was completed on June 30, 1887. The amount was 322,882 cubic yards. The price was 15.9 cents per cubic yard. The material was conveyed by water carriage through a 20-inch pipe to adjoining marshes and retained there by embankments provided and kept in order by the contractors. The material is mud, both soft and stiff. The maximum length over which the spoil was transferred is 4,600 feet. The mean height of deposit of spoil ashore above tide was 14 feet. The height of mean tide above low water is about 3 feet. The depth of digging below low water was 3½ feet. The mean height traveled by the spoil from its original level in the bed of the estuary to its point of delivery ashore was about 19 feet.

The monthly record of amounts, times, and distances is supplied by Assistant Engineer L. J. LeConte in the following table:

Month.	Month's work.	Engine.	Area excavated.	Length of pipe line.
	Cub. yds.	*Hours.*	*Acres.*	*Feet.*
December	32,386	115	3.16	1,000
January	43,623	142	3.95	1,500
February				
March	72,071	209	10.00	1,300
April	67,012	219	8.51	4,400
May	61,380	216	8.20	4,600
June	46,410	197	6.47	4,000
Total	322,882	1,098	40.29	

The area dredged was 40.29 acres and the consequent increase of tidal prism about 240,000 cubic yards. The corresponding increase of flow is close to 300 cubic feet per second.

Work in previous years increased the flow per second by 900 cubic feet. The total increase has therefore been 1,200 feet per second, which is 20 per cent. of the original tidal flow. This result has followed the dredging of 172 acres of flats in the tidal basin.

There remain to be dredged about 110 acres, or perhaps more in case marsh land comes to be surrendered by owners for the purpose.

This done, a further increase of about 450 cubic feet per second may be anticipated, which is all that can be added until the connection shall

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be made with San Leandro Basin. In storing the spoil some sloughs in the marsh land were closed through which the tide has always flowed. The loss of prism due to this cause must be deducted from the increase above stated. The loss is small, but although not yet estimated it deserves mention.

Other operations of the year were incidental, consisting of surveys, estimates, and office work.

PRESENT CONDITION.

While the jetty channel has not fully maintained its depth at all points, its sections show increased area. These indications are considered to be favorable, as they are responsive to the increase of the tidal prism elsewhere remarked as due to dredging of the tidal basin.

At a point inside the present entrance, and near the original entrance, the shoaling over the part of maximum depth since 1882 has been about 3 feet, while the increase of section is now 7.3 per cent. The flanks of the channel have been scoured to a depth of 2 to 3 feet. Outside of this point the increase of section has been about 12 per cent., with practically the original depth, while at the inner point the increase of section is 14 per cent., the maximum depth having been reduced nearly 1 foot.

The present ruling depth is 10½ feet at low water and 17 feet at high water.

The narrow ship-channel in front of the city of Oakland has maintained its depth, the only exception being at junction with the cut to the ferry wharf, where there is a deposit of 3 or 4 inches of sand, which is insignificant, and in no respect an obstruction to navigation.

No work has been done on the jetties during the year. The north slope of the north jetty has been injured to some extent during the year by the action of waves, and needs to be again filled with stone.

The south jetty remains in the same condition as at the beginning of the year.

The jetties are built of riprap stone allowed to take its natural slope. They are built, where completed, to the height of 9 feet above low water and about 1 foot above the highest spring tides. The parts exposed to the action of the natural waves and the inside slopes, which are acted upon by the forced waves developed by the large ferry steamers, are laid up with dry masonry, which, being comparatively smooth, lessens the danger of injury from waves and imparts a workmanlike appearance.

The length of the north jetty so laid up on top and inner slope is 4,855 feet. The part lying shoreward, 1,600 feet, is not intended to be laid up.

The outer division, 2,748 feet in length, is not laid up, but at some future day this may need to be done. As it now stands this division is 6 to 7 feet above low water. It stands in 7 to 8 feet depth of water and is provided with a foot-wall, upon which the dry masonry will rest. The north slope of this jetty is in no place laid up, and it is expected to leave it always simply riprap stone.

The top of the finished jetty is 4 feet wide, and the channel slope has a base of 1½ to 1 height.

The inshore division of the south jetty, 3,884 feet in length, consists of small stones, originally deposited to a height of 10 feet above low water, now settled to 9 feet or a little less. The slopes are natural and no dry masonry finish is made or contemplated.

The middle division of the jetty is 5,529 feet in length, of which 4,917 feet are finished in masonry, leaving 612 feet unfinished. The top

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and both slopes are laid in masonry. No foot-wall is needed on south side, owing to the accretion of sand, which follows the construction of the jetty.

The outer division of the south jetty, 2,465 feet in length, is all in rip-rap work. It will probably need to be extended, when other parts of the improvement come to be further advanced. The laying up in masonry may be deferred until the improvement is about to be completed, or perhaps it may be altogether omitted. As originally deposited, the top was 8 feet above low water.

FUTURE OPERATIONS

The objects to which the next appropriations are to be applied are the repair of north jetty, finishing uncompleted parts of the second division of the south jetty, and to further increase of tidal prism by dredging the basin and cutting the canal to San Leandro Bay, as the amount of the appropriations may justify.

The increase of commerce in Oakland Harbor causes applications to be made for speedier accommodations than can be expected from the progress of the work carried out according to the authorized project. Already considerable departures from the original plan have been made in dredging the channel between the jetties and in front of Oakland, in answer to demands of this kinds.

The project does not call for dredging at private or public wharves, and to this time it has not been done. The channel in front of Oakland is only 100 feet in width. It would certainly be a present advantage to have this width doubled. If sufficient appropriations are made some immediate relief might be given, while at the same time the natural progress and order of the original plan could be followed.

ESTIMATE FOR COMPLETION.

A revised estimate of the cost of completing the improvement is here given, which includes necessary bridges over the San Leandro Canal, and dredging a channel to full depth, both of which points were omitted from the original estimate made in 1874.

To finish jetties as they now stand	$30,856
Dredging channel between jetties to width of 500 feet and depth of 20 feet, low water	356,940
San Leandro Canal	413,442
San Leandro Dam	27,000
Excavation of tidal basin	150,000
Dredging channels in inner harbor 300 feet wide 20 feet at low water	129,785
Bridges over canal	200,000
Extension of south jetty, if necessary, 2,000 feet	150,000
Contingencies	132,051
Total	1,590,074

In explanation of the increase it may be said that the item of bridges is $200,000. The total cost of dredging channels by the estimate is $766,078, of which $279,453 has already been expended, whereas the original estimate included only $33,990. These items alone add $932,000 to the estimate. On the other hand, the actual cost of dredging the tidal basin promises to be about $400,000, whereas the original estimate was $799,525. The jetties were originally estimated to height of 4 feet above low water at a cost of $401,500. As constructed they are to be 9 feet above low water, and are expected to cost $573,055.33.

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Attention is asked to the following statistics collected by Assistant Engineer L. J. LeConte, showing the increase of travel and freight that now passes through the channel over the amounts existing at the beginning of the improvement:

APPROPRIATIONS AND EXPENDITURES.

The total amount appropriated by Congress for this work is $934,600, and the amount expended, including liabilities on June 30, 1887, is $926,321.72.

The nearest port of entry is San Francisco, at which during the fiscal year $6,857,445 were collected in customs duties.

Money statement.

July 1, 1886, amount available		$4,129.71
Amount appropriated by act approved August 5, 1886		60,000.00
		64,129.71
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$43,831.81	
July 1, 1887, outstanding liabilities	12,019.62	
		55,851.43
July 1, 1887, amount available		8,278.28
Amount (estimated) required for completion of existing project		1,590,074.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of bids for dredging in Tidal Basin, Oakland Harbor, California. Proposals opened October 21, 1886, at 12 m., by Col. G. H. Mendell, Corps of Engineers.

Names of bidders.	Per cubic yard.	Remarks.
	Cents.	
*Alexey W. Von Schmidt and Duncan McNee	15.90	Excavated and placed ashore.
Pacific Dredge Company	17	Do.
Henry H. Lynch	18	Do.

* Contract awarded to Von Schmidt & McNee, dated October 27, 1886.

COMMERCIAL STATISTICS.

Years.	Traffic by steam ferries.				Traffic by vessels.		
	No.	Trips.	Passengers.	Freight.	No.	Register.	Freight.
				Tons.		*Tons.*	*Tons.*
1874	1	600	None.	60,000	1415	70,750	94,300
1878	3	5,400	216,240	129,000	1085	109,125	211,627
1882	3	8,800	858,352	1,051,788	1129	129,714	173,448
1883	3	9,400	892,210	1,150,379	1004	144,004	257,614
1884	3	8,000	974,901	1,142,918	1031	143,886	215,829
1885	3	8,000	1,553,769	1,202,230	1157	163,553	255,738
1886	3	6,000	444,142	1,439,184	1326	200,226	305,437
1887	3	6,000	318,402	1,487,924	1673	188,947	264,050

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By combining the above statistics we have the following comparative grand totals of traffic through the jetty channel, wherein it will be observed that the increase in thirteen years has been over tenfold the original amount:

Traffic.	1874 (before improvement).		1887 (after improvement).	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*
By ferry	None.	60,000	318,402	1,487,924
By vessels	None.	94,300	.....	264,050
Total	.....	154,300	318,402	1,751,974

Q Q 2.

IMPROVEMENT OF REDWOOD HARBOR, CALIFORNIA.

The improvement consists in dredging a channel 6,000 feet in length, near the town, to a depth of 3 feet at low water. The depth at high tide will be sufficient for the class of vessels engaged in the trade.

Bids were invited for the purpose of putting the work under contract, but the Government dredge having just been completed, and there being no other employment for it, the bid was declined, and the Government dredge was put on the work by authority of the War Department.

The dredge began work on April 25, and by June 30 it had gone over about 2,900 feet of the channel, and had excavated about 19,000 cubic yards, giving a channel 50 feet wide and about 2½ feet in depth at low water, to which the tide adds from 4 to 6 feet at high water.

The dredge being just from the shop, and being put to its first work, and the crew being untrained, not much progress was made during the first month. The material in the bed of the channel was found so stiff as to choke the pipe and to cause great delays. Some minor modifications were made in the dredge, and these, with added experience, have since caused better progress. The spoil is placed ashore. The dredge is to continue on this work until it shall be required upon the rivers, for which it was especially built, unless the available funds shall be first exhausted. They are sufficient to include the month of August.

The appropriation herein asked for is intended to continue the improvement, and it is expected to complete it as originally projected.

Redwood City is a prosperous town of 2,000 or 3,000 people, from which there is a considerable export of lumber, leather, tan-bark, and agricultural products. The town is situated at the head of a large tidal channel which makes out of San Francisco Bay.

Its commerce is carried by sloops and schooners of 50 tons capacity, more or less. The bed of the channel near the town being dry at low water, these vessels necessarily are of less draught than the rise of the tide, and can reach or leave the port only at the stage of high tide. The delays incident to this condition of the channel must disappear when the improvement shall be completed, and it will be possible to employ somewhat larger vessels in the trade.

This portion of the channel, lying near the town, is the only part needing improvement at present. The lower channel was examined during the past season and found to be convenient under present conditions of navigation.

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It is recommended that the full appropriation be made. A less sum will not only increase the final cost, but if the appropriation be much less than asked, it will be insufficient to justify resumption of work, and in that case it may be judicious to hold the money until increased by an additional appropriation.

Money statement.

July 1, 1886, amount available		$3.000.00
Amount appropriated by act approved August 6, 1886		5,000.00
		8,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$2,935.16	
July 1, 1887, outstanding liabilities	1,609.08	
		4,544.24
July 1, 1887, amount available		3,455.76
Amount (estimated) required for completion of existing project		7,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		7,400.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for dredging at Redwood, Cal. Proposals opened at 12 m. March 30, 1887, by Col. G. H. Mendell, Corps of Engineers.

Name of bidder.	Price per cubic yard excavated.
	Cents.
M. J. Madison	24

This being the only bid, it was declined.

STATEMENT OF AMOUNT OF COMMERCE AND NAVIGATION TO AND FROM REDWOOD CITY VIA REDWOOD CREEK FROM JULY 1, 1886, TO JULY 1, 1887.

[Furnished by Hanson & Co.]

IMPORTS.

Pine lumber	M feet	4,250
Redwood lumber	do	1,200
Coal	tons	1,500
General merchandise	do	4,500
Hides, bark, oils, etc. (tanners' stock)	do	4,000

EXPORTS.

Redwood lumber	M feet	5,000
Shingles	M	35,000
Split posts		425,000
Wood	cords	8,000
Tan-bark	do	3,500
Grain	tons	7,000
Hay	do	8,000
Tanners' goods (leather, gluestock, etc)	do	2,000

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QQ 3.

SURVEY OF SAN FRANCISCO HARBOR, SAN PABLO AND SUISUN BAYS, STRAITS OF CARQUINEZ, AND MOUTHS OF SACRAMENTO AND SAN JOAQUIN RIVERS.

The act of August 5, 1886, appropriated the sum of $11,000 for the survey of San Francisco Harbor and the interior bays, extending to and including the mouths of the San Joaquin and Sacramento rivers.

It was found that parties of the Coast and Geodetic Survey were in the field, or making preparations to that end, in the month of August, intending to cover San Pablo and Suisun bays. It not being desirable to repeat at once a survey made by another department of the Government, the operations of the Engineer survey were deferred to await the action of the Coast Survey parties.

The part of the area named in the bill not covered by the Coast Survey is to be undertaken by the Engineer Department, so far as the funds available will permit. No operations have yet been undertaken, but it is expected to make a survey during the coming summer and autumn of San Francisco Harbor from the heads to Hunter's Point.

There were no expenditures during the year.

QQ 4.

REMOVING SUNKEN VESSELS OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK ESCAMBIA.

At the date of the last annual report there was a minimum depth of 4½ fathoms on portions of the wreck; subsequently a depth of only 13 feet at low water was found on the boilers.

The contractor began operations on July 7, and continued with many and prolonged intermissions, but with fair success, until the end of December, by which time he had removed and placed on the wharf in San Francisco 197.1375 tons.

During January, February, March, and April no recovery was made, the vessel being detached for repairs and other purposes about half of the time, and the sea being too rough for work during the remainder of the time. In May about 6 tons, and in June about 20 or 25 tons were recovered, not yet weighed. The total result for the year is therefore about 226 tons removed and deposited.

The fragments of the wreck being delivered in irregular and unmerchantable masses, it was necessary to provide for separating them as far as practicable into salable forms and sizes. An agreement was made with George Green to cut the iron into such forms at the rate of $4.75 per ton, including weighing, and 75 cents per ton for hauling from the wharf to the place of deposit and piling.

During the year 154.7 tons were cut under this agreement.

On September 24, 48,593 pounds of recovered anchors and chains were sold, bringing a net amount of $1,339.80, and on January 5, 345,682 pounds of miscellaneous iron and brass were sold, netting $2,610.08. These sums, aggregating $3,949.88, were turned into the Treasury. Both sales were made at auction after advertisement.

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The year's result has not been as favorable as anticipated.

The position of the wreck is one of great exposure, and during the summer months of July, August, and September there were but thirty-two days on which work could be done, while in April the sea did not permit a single day's work to be done. It is, however, expected that the work may be completed during the present season. This may not be the case, if it proves necessary to remove the whole or nearly the whole wreck. It is intended to remove such portions only as can be regarded as dangerous, but it has been impossible up to this time to make any close estimate of the quantity requiring removal. The weather has not yet permitted a careful examination of the present condition to be made, which, when accomplished, may enable a closer estimate to be given. Since the close of the fiscal year about 80 tons have been recovered, which include the greatar part of the two boilers, which were noted as especially dangerous.

Amount expended during the year	$9,422.54
Amount turned into the Treasury from sales	3,949.88
Difference	5,472.66

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APPENDIX R R.

IMPROVEMENT OF THE HARBORS OF WILMINGTON AND SAN DIEGO, CALIFORNIA.

REPORT OF MAJ. W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Wilmington Harbor, California. 2. San Diego Harbor, California.

SURVEY.

3. San Diego, Newport, and San Luis Obispo harbors, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal.

SIR: I have the honor to transmit herewith annual reports upon works under my charge, for the year ending June 30, 1887.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major Engineers.

The CHIEF OF ENGINEERS, U. S. A.

R R 1.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

The improvement of this harbor was begun in 1871. At that time the entrance had a depth at low tide of about 1 foot. The operations carried on since that date have resulted in securing a greatly increased depth and width of channel, so that vessels drawing 15 feet can now enter the harbor and unload at the wharves.

The project now in course of execution is intended to gain all possible depth at the entrance, estimated to be 14 to 16 feet.

A hydrographic survey made during the month of May shows a deepening and widening of the interior channel and an increase of depth at the entrance. While for a short stretch only in the interior channel, near

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the angle on the west jetty, a depth of about 10 feet is found, there is throughout the remainder of the channel a depth of 12 feet and over.

The condition of the works themselves remain about as at the date of the last annual report.

No operations were carried on during the past year. The movable property and stores are, with the lighters and boats, left in charge of a keeper. A contract was entered into in November last with A. W. Von Schmidt, for dredging 135,000 cubic yards of material from the channel. As the dredger was engaged in the work at Oakland Harbor, the date of commencing the work at Wilmington was fixed at May 1, and afterwards extended by me until July, the price at which the contract for dredging was let, being much lower than anticipated and so favorable that a balance of the appropriation was left for other operations. Accordingly, after due advertisement a contract was made for 8,000 tons of stone for raising and extending the west jetty.

These operations will be commenced in July, and constitute the work to be done during the coming season.

With the appropriation asked for it is intended to extend the west jetty, dredge the interior channel and sand at the entrance, and to keep the work in good order.

Money statement.

July 1, 1886, amount available		$1,395.60
Amount appropriated by act approved August 5, 1886		75,000.00
		76,395.60
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$4,681.54	
July 1, 1887, outstanding liabilities	58,070.00	
		62,751.54
July 1, 1887, amount available		13,644.06
Amount (estimated) required for completion of existing project		175,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		125,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

Abstract of bids for dredging, called for by advertisement of Col. G. H. Mendell, and opened by him November 8, 1886.

Name of bidders.	Per cubic yard excavated.
	Cents.
Allexey W. Von Schmidt	29.8
Pacific Coast Dredging and Reclamation Company	50
Henry H. Lynch	57.2

Abstract of bids for delivering stone, called for by advertisement of Maj. W. H. H. Benyaurd, and opened by him, May 31, 1887.

Name of bidders.	Price per ton.
Edward A. Von Schmidt	$2.23
San Francisco Bridge Company	2.39

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COMMERCIAL STATISTICS.

For the year 1871.

	Steamers.	Sailing-vessels.	Freight.	Lumber.
			Tons.	*Feet.*
Incoming	160	65	25,313	10,938,336
Outgoing	160	65	9,575	.....

For year ending June 30, 1887.

[Draught, greatest, 24 feet, outer harbor.]

FOREIGN COMMERCE.

Entered:	
Steam-vessels	1
Sailing-vessels	67
Tonnage	92,214
General merchandise, tons	250
Coal, tons	118,536
Cleared:	
Steam-vessels	1
Sailing-vessels	67
Tonnage*	5,776

DOMESTIC COMMERCE.

Entered:	
Steam-vessels	168
Sailing-vessels	338
Tonnage	367,243
General merchandise, tons	31,258
Coal, tons	257
Lumber, feet	125,543,000
Cleared:	
Steam-vessels	168
Sailing-vessels	338
Tonnage	367,243
General merchandise, tons†	7,556

The total amount of revenue collected during the year ending June 31, 1887, was $98,505.44. The rates upon freight have been reduced, since the first expenditure for the improvement of the harbor, from $7.50 to $4.12½ per thousand feet on lumber, and from $5 to $2.50 per ton on general merchandise, from the outer anchorage.

R R 2.

IMPROVEMENT OF THE HARBOR OF SAN DIEGO, CALIFORNIA.

The object of this improvement is to prevent the harbor from being a place of deposit of the material brought down by the San Diego River during flood stages.

The improvement was commenced in 1875 and completed in 1876, and consisted in cutting a new outlet for the river, causing it to empty into False Bay, and in building a levee closing up the old channel of the river, and preventing the flow into the harbor.

Since the completion of the project, the work has consisted simply in keeping the levee in repair. While the general condition of the levee

* Wheat, valued at $151,710. † Per steamer; sailing-vessels going in ballast.

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is good, it is in need of repair; cattle have worn trails across it at a number or points, and have thrown down portions of the rock facing. The embankment has also been injured by the burrowing of animals and the wash from rain-storms.

The amount appropriated since 1875 is $81,000, and the amount expended $80.888.81.

This work is in the collection district of San Diego; that town is the nearest port of entry. The nearest light-house is at Point Loma, and the nearest fort is that begun at Ballast Point.

The amount of revenue collected during the year ending June 30, 1887, is $29,847.19.

Money statement.

July 1, 1886, amount available	$548.55
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	437.36
July 1, 1887, amount available	111.19
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts 1866 and 1876.	1,000.00

COMMERCIAL STATISTICS.

For the year in which the improvement began.

	No. of vessels.*	Freight.
Entered	201	24,889
Cleared	195	11,647

* With an aggregate tonnage of 122,311 tons (including 109 ocean steamers).

For the year ending June 30, 1887.

	Entered.						Cleared.		
	Vessels.	Tonnage.	Greatest draught.	General merchandise.	Coal.	Lumber.	General merchandise.	Coal.	Lumber.
	No.		*Feet.*	*Tons.*	*Tons.*	*Feet.*	*Tons.*	*Tons.*	*Feet.*
Steam ..	146	185,406	24	(*)	26,213	71,047,054	16,000	†20	†4,000,000
Sailing ..	201								

* Not given. † About.

Total amount of revenue collected during the fiscal year ending June 30, 1887, $29,847.19.

R R 3.

SURVEYS OF SAN DIEGO HARBOR, NEWPORT HARBOR, AND SAN LUIS OBISPO HARBOR, CALIFORNIA.

An examination of the harbor of San Luis Obispo with a view to the establishment of a breakwater at or near Whaler's Reef was made in January last, and the report thereon was submitted to the Department

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under date of January, transmitted to Congress, and printed in Senate Ex. Doc. No. 81, Forty-ninth Congress, second session.

For the other surveys a party was organized in January, and commenced the survey of the harbor of San Diego. Upon completion of this work the party was transported to Newport for the survey of the harbor at that place.

The notes of these surveys are now being worked up by the chief of the party, and the reports will be transmitted to the Department when completed.

Money statement.

Amount appropriated by act approved August 5, 1886	$5,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	3,383.41
July 1, 1887, amount available	1,616.59

EXAMINATION OF HARBOR OF SAN LUIS OBISPO, CALIFORNIA, WITH A VIEW OF ESTABLISHING A BREAKWATER AT OR NEAR WHALER'S REEF.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 28, 1887.

SIR: I have the honor to present the following report of the result of an examination of the harbor of San Luis Obispo, Cal., with a view of establishing a breakwater at or near Whaler's Reef, as provided for in the river and harbor act of August 5, 1886.

This matter was made the subject of official reports upon two former occasions by Colonel Stewart, Corps of Engineers, whose reports will be found in those of the Chief of Engineers for 1879, page 1765, and 1881, page 2526. As a complete hydrographic survey of the bay had been made by the Coast Survey, a chart of which was in our possession, no additional survey was deemed necessary. It was, however, thought advisable on the present occasion to supplement the information heretofore presented by having an examination made of the adjacent country, to ascertain if stone, suitable for the construction of the breakwater, could be obtained, and if so, to prepare estimates based thereon for the cost of the structure.

The clause providing for the survey required an estimate for establishing a breakwater one-quarter of a mile (more or less) along the sunken reef near Whaler's Island. The project heretofore reported upon contemplated a longer length of breakwater upon the same line, and also an additional structure 1,350 feet in length to the northward and eastward of the extremity of the reef, so as to cut off from the inclosed space heavy seas coming from the south and southeast.

The reports of Colonel Stewart referred to above contain full descriptions of the bay (with map), and set forth fully the condition of prevailing winds and seas at the locality that would call for the construction of a breakwater. With this information at hand I have not deemed it necessary to repeat it here, as reference can be made thereto.

High hills shelter the harbor from winds from west around by north to the east, and from that to southeast it is more or less exposed, and

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from south-southeast to southwest it is open to wind and sea. For the greater part of the year the harbor is a good one, and it is only during the winter months, when the prevailing winds are more or less from the southward, that the anchorage becomes exposed to storms from that quarter. Owing to local conditions it is stated that the southerly and southeasterly winds do not cause any dangerous disturbances in the anchorage, while the sunken reef that extends out from Point San Luis acts to some extent as a breakwater against the swells from the southward and westward.

The estimated cost of the breakwater, as presented by Colonel Stewart, was $1,884,192.45 for that portion along the reef extending out some 3,000 feet beyond Whaler's Island, and $5,425,284.54 for the detached breakwater. The opinion, however, was expressed in rendering the reports that no work was needed there, and that the benefit to commerce from any harbor improvement, as suggested, would not be sufficient to warrant the expenditure therefor.

The clause in the act directing the present survey limited the length of the breakwater to be constructed along the reef near Whaler's Island to one-quarter of a mile (more or less). Referring to the map it will be seen that at a point some 2,300 feet from Point San Luis, and about 1,800 feet from Whaler's Island, the reef rises above high water, and it is presumed that in indicating the length of breakwater to be built as above it was intended that it should extend to that point. While such a breakwater would afford no protection to seas from a southeasterly direction, it would allow for a protected anchorage over an area of more than 250 acres from the swell from the southwest.

In estimating for a breakwater, thus projected, it is proposed to fill up the gaps in the sunken reef and to raise the whole mass up to mean low water, and to extend out to the outcropping of the ledge as above. This will protect the anchorage from swells from the southwest, and is deemed sufficient for the present. The commerce of the country, of which Port Harford is the outlet, is on the increase, as shown by the comparative statement herewith. Should it at any future time be deemed advisable to extend the breakwater providing for additional anchorage ground, it could be carried out on the same line, but at a great increase of cost, necessarily.

From a careful examination of the hills and country adjacent to the bay it is not thought likely that the locality can be depended upon to produce all the material needed for the construction of the breakwater. At Point San Luis rock can be obtained that will do for filling, and at a point about one-quarter of a mile from the steamship wharf a ledge is being opened by the railroad company from which a quantity of good material can be procured, and sufficient to develop the certainty of depending upon it for additional supply. After a careful search of the neighboring country for miles, these two points were the only ones that gave indications of rock suitable for the construction and with reasonable facilities for transportation. The stone from these quarries, as well as that which must be procured from distant points, may be used for the base and filling, and it may be possible in developing the quarries to obtain stone in large masses, though the greater part needed for the top and facing must be made of artificial blocks.

In constructing the breakwater it is proposed to raise it to the level of mean low water, and give it a thickness on top of 25 feet. The outer face will have a slope of 1 on 3, and the inner 1 on 1. This will require 91,295 tons of rock, considering the whole mass as solid. I estimate

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that about one-fifth will cost at the rate of $5 per ton and the remainder at $2 per ton.

18,275 tons, at $5	$91,375
73,020 tons, at $2	146,040
	237,415
Contingencies, 20 per cent	47,483
Total	284,898

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Major, Engineers.

Brig. Gen. J. C. DUANE,
Chief of Engineers, U. S. A.

Imports and exports, Port Harford, California.

Year ending—	Exports of general merchandise.	Imports.	
		Lumber.	General merchandise.
	Tons.	*Feet.*	*Tons.*
October, 1878	8,170.29	3,133,266	7,717.26
December, 1880	17,174.30	1,595,415	3,380.74
November, 1886	39,159.5	4,158,000	7,076.5

REPORT OF COL. GEORGE H. MENDELL, CORPS OF ENGINEERS, SUPERVISING ENGINEER.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 2, 1887.

SIR: The project for San Luis Obispo Harbor submitted on the 28th ultimo by Major Benyaurd brings the construction of the breakwater on the reef to the plane of mean low water and not above it.

There is some reason to think that it never will be necessary to carry the work higher, but if it should turn out in the future to be expedient to raise it the change can be made simply by addition of material to the first structure. Nothing belonging to the future is sacrificed by the proposed construction, which will be a part of the larger work if ever built. It is thought that a structure brought to the plane of low water will effectually break the waves and cover the anchorage from most of the exposure. The waves will not be able to reach the anchorage in any great intensity. They will be compelled to expend their living force before reaching the anchorage. This remark applies to those waves only which pursue a path across the proposed line of occupation.

The cost of a work brought to this level is to the cost of one carried to 10 feet above high water, an increase of height of 16 feet, as 1 is to 4. The estimate along the line proposed, 2,300 feet long, for a low water work, is $284,898, and for the higher work the estimate is $1,144,096.

It is proper to remark that the project is confined to the limits expressed in the last river and harbor act, and that it does not consider

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the whole problem of harbor protection. The latter can well be postponed until the commercial interest of the port shall be largely increased. The present project ought to and does well cover the necessities of the harbor for some years to come, and it forms a part of any enlarged scope of improvement that may be undertaken hereafter.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX SS.

IMPROVEMENT OF ENTRANCE TO HUMBOLDT BAY; OF SAN JOAQUIN, MOKELUMNE, SACRAMENTO, AND FEATHER RIVERS, AND PETALUMA CREEK, CALIFORNIA.

REPORT OF CAPTAIN A. H. PAYSON, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Joaquin River, Stockton and Mormon sloughs, California.
2. Mokelumne River, California.
3. Sacramento and Feather rivers, California.
4. Petaluma Creek, California.
5. Humboldt Harbor and Bay, California.
6. Colorado River, Nevada, California, and Arizona.

EXAMINATION.

7. Mouth of Smith's River, California.
8. Crescent City Harbor, California, with a view to a sea-wall from Battery Point to Flat Rock.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 29, 1887.

GENERAL: I have the honor to transmit the annual reports of the river and harbor works under my charge for the fiscal year ending June 30, 1887.

Very respectfully, your obedient servant,

A. H. PAYSON,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

S S 1.

IMPROVEMENT OF SAN JOAQUIN RIVER, STOCKTON AND MORMON SLOUGHS, CALIFORNIA.

The approved project has for its object the maintenance by dredging of a channel 9 feet deep at low water and 100 feet wide through the tidal parts of the river below Stockton; a channel 4 feet deep at low water and 80 feet wide in Mormon Slough to Miller's Warehouse; and

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temporary improvements in low-water channels of the upper river to Hill's Ferry, carried on by the United States snag-boat *Seizer*.

The dredging has hitherto been done by contract, but a dredge having been built during the past year under authority of an act of Congress for this purpose, the project must now be modified to provide for dredging hereafter by hired labor.

Of the total amount appropriated, namely, $158,750, $139,481.72 was spent prior to June 30, 1886, of which $105,633.93 was for dredging, and $33,847.79 for snagging and other temporary measures.

An examination of the river in August, 1886, having shown that the required channel in Stockton Slough was seriously interrupted, with much inconvenience to the navigation, a project was submitted to the Department for dredging by contract to secure 8 feet depth by 100 feet width over three bars, for a total distance of some 1,300 feet.

These diminished dimensions of the channel were recommended as giving sufficient temporary relief, and because the completion of the Government dredge would probably enable us to restore the channel depths of the original project more economically the following season.

Proposals were opened September 27, and contract made October 1, 1886, with Mr. H. Lynch, the lowest bidder. Work was begun October 12, with a suction dredge, and finished December 16; the proposed channel having been secured across the shoals at the mouth of Mormon Slough, the Sister Sloughs, and in the "Narrows," which made it continuous below Stockton.

In this contract and superintendence was expended the sum of $4,984.98, with removal and deposit on bank of 18,819 cubic yards of material.

During November, 1886, it was decided to take advantage of the very low water in removal of some snags in the upper river which had become the cause of serious complaint. Two experienced men were sent from Stockton with skiff, tools, powder, etc., and started down-stream from Hill's Ferry, November 26. They reached Stockton in return December 21, having cleared the intervening river of all dangerous snags with a thoroughness only possible at the extremely low stage, due to the lateness of the winter rains, which fortunately continued during the work.

There was expended in these operations the sum of $413.74 with removal and destruction of 86 snags.

For reasons given in preceding annual reports no attempt at radical and permanent improvements of the Upper San Joaquin is thought justifiable, but valuable relief to the navigation can be afforded by sending the snag-boat into the river for a short season in the early spring, and by such operations during the winter low water as have been described for last year.

The tidal channels below Stockton are used by a large and increasing commerce, and by no engineering device can the scour in Stockton and Mormon sloughs be made equal to the task of removing the deposits from land drainage, increased as they have been by hydraulic mining. Dredging will always be necessary for the maintenance of these channels and upon shoals in the main river for a short distance below the mouth of Stockton Slough.

Like any other repair this dredging can be done with a maximum of benefit and minimum of cost if it is regularly done each year; and this is specially the case now that the Government owns its own dredging machinery. In the absence of experience in such systematic annual work it is impossible now to estimate the annual expense of main-

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tenance of the projected channels below Stockton, but it is believed, especially with the means available now, for doing the work at cost, that when once these channels are established the expense will not be incommensurate with the important interests to be served.

Any measure which facilitates the ingress of the tide for the San Joaquin estuary will increase the scour and aid other means for the preservation of its depths. In this view, as well as to avoid the difficulty found by the boats in use in turning certain sharp bends, cut-offs have been made at these points below Stockton Slough. These have more than fulfilled all expectations of their usefulness and have maintained themselves well with the natural closure of the old channels.

A valuable extension of this system can be had in two more cut-offs at Twenty-one Mile Slough and Head Reach, which would shorten the river about 8,000 feet and involve the removal of about 900,000 cubic yards of material at an estimated expenditure of $125,000, which should be made in two years.

In my last annual report and a previous special communication on the same subject a recommendation was made for the partial closure of Paradise Cut, a crevasse in the left bank of the San Joaquin, which it was feared might, by its enlargement, which is constantly going on, divert enough water to harm the important navigation of the main river below the mouth of Stockton Slough.

This recommendation is repeated as follows:

That the cut be closed by a weir, with its top 8 feet above low water, by which the discharge of Paradise Cut at stages between 4 feet and 8 feet above low water will be added to the low in the navigable channels.

The amount estimated for completion of existing projects, not including the dredging and snagging which will be annually necessary, are as follows:

Paradise Cut	$14,000
Cut-offs	125,000

The amounts which can be profitably expended during the fiscal year are for works as follows:

Dredging and snagging	$40,000
Paradise Cut Dam	14,000
Cut-off	65,000

Money statement.

July 1, 1886, amount available	$518.28	
Amount appropriated by act approved August 5, 1886	18,750.00	
		19,268.28
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		5,398.72
July 1, 1887, amount available		13,869.56

Amount (estimated) required for completion of existing project, exclusive of dredging and snagging	139,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	119,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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Abstract of bids for dredging in Stockton Slough received by Capt. A. H. Payson, Corps of Engineers, and opened at 12 m., September 27, 1886.

No.	Names of bidders.	Price per cubic yard.	Remarks.
		Cents.	
1	H. H. Lynch	24½	Accepted.
2	Von Schmidt & McNee	27	

Contract awarded to H. H. Lynch, dated October 1, 1886.

STATISTICS.

The following statistics are furnished by Mr. R. E. Wilhoit, secretary of the San Joaquin County Board of Trade, at Stockton, Cal.

Freight shipped to and from the city of Stockton via the San Joaquin River during the fiscal year ending June 30, 1887.

EXPORTS.

	Tons.
Wheat, barley, and other cereals	93,000
Flour and mill stuff	60,000
Vegetables, potatoes, onions, etc	30,000
Fruit and grapes	5,000
Furniture, carriages, and agricultural implements	1,000
Paper	1,200
Leather	1,500
Wine and brandy	750
Hides, pelts, and glue stock	500
Miscellaneous freight	18,000
Total	210,950

IMPORTS.

Agricultural implements	4,000
Miscellaneous machinery and hardware	25,000
Paper stock and chemicals	1,200
Hardwood, lumber, and carriage stock	1,500
Building and fencing lumber	80,000
Coal	45,000
Lime and cement	1,700
Tan-bark	4,000
Miscellaneous freight	30,000
	192,400

Freight transported by steamer and barges upon the Upper San Joaquin River during the fiscal year ending June 30, 1887.

DOWN FREIGHT.

	Tons.
Wheat to San Francisco	25,000
Wheat to Stockton	15,000
Hay, potatoes, and other agricultural products	2,000
Wool	1,000
Wood	1,500
Total	44,500

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UP FREIGHTS.

	Tons.
Lumber from San Francisco	2,000
Lumber from Stockton	2,000
Miscellaneous freight from San Francisco	8,000
Miscellaneous freight from Stockton	17,000
Total	29,000

S S 2.

IMPROVEMENT OF MOKELUMNE RIVER, CALIFORNIA.

The project adopted in 1884 has for its object the removal of snags and overhanging trees in that part of the river within tidal influence where there is a sufficient depth for navigation. This work to be done by hired labor and the United States snag-boat.

The stream separates into two arms called, respectively, the north and south forks, which reunite below, inclosing a large tract of fertile and partly reclaimed land called "Staten Island."

The work of the snag-boat in previous years had resulted in a safe channel by the north fork to the head of navigation; but the south fork for about 2 miles below its junction with the north was so choked with snags as to be impassable.

During November and December, 1886, the snag-boat worked twenty-six days in clearing the head of the south fork, which was made a safe channel for any boat not too large to turn the bends, by the removal of 174 snags and 183 trees and with the expenditure of $2,503.10.

The channels established are liable to injury by snags brought in by winter floods, and for their annual removal a small expenditure seems justifiable. It is proposed with the funds asked for to continue the work of snagging as it becomes necessary.

As the project contemplates annual work, no estimate for its completion can be given.

Money statement.

July 1, 1886, amount available	$42.52
Amount appropriated by act approved August 5, 1886	2,500.00
	2,542.52
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,503.10
July 1, 1887, amount available	39.42
Amount that can be profitably expended in fiscal year ending June 30, 1889 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

S S 3.

IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

The project has for its object the temporary improvement of the low-water channel by snagging, dam building, and bar scraping, carried on by hired labor and the crew of the United States snag-boat *Seizer*.

During the past year the *Seizer* was engaged on these rivers one hundred and six days, of which, on account of low water, only one day could be spent on the Feather River in snagging.

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On the Sacramento, seven days were spent in dam building; nine days in bar scraping at Jacinto, Salmon Bend, and Six Mile Bar, and eighty-nine days in snagging, with the removal of 1,029 snags and 250 trees, and the destruction of 151 snags previously removed. The boat in this work ran 1,667 miles.

The river during the season reached within 3 inches of the low-water depth of the preceding year, and the navigable depths of last season were also practically maintained, as follows:

Head of navigation to Butte City	inches	30
Butte City to Colusa	do	36
Colusa to mouth of Feather River	feet	4½
Mouth of Feather to Sacramento	do	4

The available depths at Salmon Bend and Six Mile Bar—both below the Feather River—having become less than 4 feet the last part of September, were restored at Salmon Bend by scraping and increased at Six Mile Bar to 6 feet by a log and brush dam 430 feet long, built in four days.

By the 1st of November the channel to the head of navigation was in good order, with 4½ feet from Colusa to Sacramento, and all trouble over for the season; but the boat staid in the river until the 12th, making a final trip to the head of navigation for the removal of such snags and trees as threatened to become troublesome during the coming winter. On the 15th the boat left the river for the Mokelumne.

There seems no reason to modify the views expressed in previous reports to the effect that a continuance of the measures heretofore employed will meet the demands of the navigation above the mouth of the Feather for many years to come.

Below the Feather the large deposits brought in by that stream, the great width and feeble currents of the Sacramento, and the exhaustion of the natural supply of material for temporary dams seriously complicates the question and difficulties to the navigation, which is well accommodated by the river above, will be doubtless met in each succeeding season, and found beyond our power of remedy with existing means.

Regarding any project for a permanent and continuous improvement in this part of the river as now out of the question, I have nothing to suggest further than the possibility of replacing the snags and trees hitherto used in temporary dams by some cheap artificial construction, the material of which could possibly be removed after its purpose has been served.

Experiments to this end have been made with a few light cribs, which were found efficient, but the lack of funds this season will prevent any attempt for this removal and further use.

The snag-boat returned to Sacramento and went out of commission on the 11th of December, 1886, but could not be hauled out for repairs on account of the stage of the river before January 1.

A survey of the boat having been made, and project for repairs submitted to and approved by the Department, with authority for hired labor and purchase of material in open market, work in accordance began February 9, and was completed during March at a cost of about $2,500.

The following is a summary: Bottom planking spikes set in and butts calked; thick streak above knuckle on both sides the whole length of the boat, with some of the side planking renewed and seams recalked; oak bow sheathing partly renewed and extended 8 feet further aft on both sides; most of forward deck planking, plank shear oak nosing

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piece of bow, and forward bitts replaced by new; derrick mast shortened 3 feet, and step and guys renewed.

A new transom was put in, and the rudder stocks replaced by others of heavier iron. Slight repairs were made to the boiler, and the machinery was entirely taken apart and overhauled, cylinders and slides lined over, and cocks, journals, and frames reground and refitted.

During the rest of the year the boat with the barge lay idle in Sacramento under charge of a watchman, who employed a portion of his time in the necessary painting. The *Seizer* is now in her seventh season, and as the life of such a boat is about ten years—and this one has had very hard use—extensive repairs will doubtless be annually required, and at no distant day a new boat will have to be provided for.

During the season there were no accidents to the boats or barges in use upon the Sacramento River.

By the act approved August 5, 1886, provision was made for such legal proceedings as were necessary to satisfy the honorable the Secretary of War of the cessation of hydraulic mining hurtful to navigation on the tributaries of the Sacramento, the expenses of which, as well as those of the snag-boat, were to be paid out of the allotment of $40,000 made by the same act from funds previously appropriated.

By a subsequent decision of the honorable the Secretary, the sum of $15,000 out of the $40,000 was set apart for these legal proceedings, and this reservation, added to the expenditures of last season with the snag-boat, left us this spring, in the failure of the last river and harbor bill, with a balance of only about $9,000 available for work on the river and care of property to the end of this fiscal year. This will doubtless result in much inconvenience to the navigation this season, and a large increase in the necessary work next year.

I have purposely kept the boat idle as long as possible so that the six weeks or so which could be utilized with the available funds, might be employed to the best advantage; but the condition of the river has now become so dangerous that some work has to be done.

The boat will be again laid up by the middle of August, while the lowest water and worst trouble may be expected in September, when it will be out of our power to render any assistance.

CONSTRUCTION OF DREDGE.

The dredge under contract at the beginning of the fiscal year was launched September 28. Steam kept on the boilers several days in succession, and all gearing, shafting, etc., was found to work in a perfectly satisfactory way, but no thorough trial of the machine could be made until the centrifugal pump-discharge had been put in place, which the original allotment of $40,000 had not enabled us to make contract for.

An additional sum of $10,000 having become available by the act of August 5, 1886, supplementary contracts for the pump, steel discharge-pipe line, and supporting pontoons, were approved during October and November, and these contracts having been satisfactorily carried out by the end of January, the final adjustments of the machinery were made, and a trial having been had of all the machinery and appliances, the dredge was accepted and the reserved payments made on March 1.

A complete outfit of engine-room, fire, and machinists' tools, ropes, blocks, kitchen furniture, etc, was purchased, and during the fore part of April the dredge was turned over to Colonel Mendell, Corps of Engineers, for use on the work under his charge in Redwood Creek.

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The subsequent severe trial of the machinery in hard clay has developed excellent qualities, and I am in hopes that it will be found everything to be desired for the special class of work on the San Joaquin River, for which it was designed.

Some minor modifications in the friction gears swinging the ladder, and in the spud housings, resulting in a material increase in efficiency, have been made with the Department's approval since work began at Redwood.

LEGAL PROCEEDINGS.

The act of August 5, 1886, contained a provision that the $40,000 therein made available from the money before appropriated, should be used in dredging, snagging, and certain legal proceedings against persons engaged in hydraulic mining hurtful to navigation, and under date of October 26, 1886, I reported to the Department my opinion, in effect that while such legal proceedings could not be expected to prevent the evils complained of, that the appearance of the United States as an applicant for injunction in one or more cases of illegal hydraulic mining might have a good moral effect, and would be in accordance with the will of Congress as expressed in the law.

These views received the approval of the honorable the Secretary of War and the Department; and under subsequent instructions from the latter I received the necessary engineering assistance and made certain examinations in portions of the hydraulic mining field tributary to the Sacramento River.

These examinations convinced me that mining contrary to law was going on in a small way in many places, and that more was planned when the water supply became sufficient in the later spring. The results in the shape of a detailed report from my assistant engineer were submitted to the United States district attorney by letter from me dated February 28, 1887, in which I suggested that if the information found in the report was considered sufficient foundation for even a single application for an injunction, that such application be made; and further expressed an opinion that the instructions under which we were jointly acting did not cover an attempt to enjoin every hydraulic mine not already under injunction, and that the course suggested would fulfill them in their present scope.

The United States district attorney was of the opinion that his instructions from the Attorney-General could best be carried out by an attempt to enjoin all the hydraulic mines in operation in the State, or at least in any one district, at the same time, and, while waiting for more definite instructions, for which he had applied, took no action on the report submitted with my letter of February.

All these facts and the difference in view between the district attorney and myself were reported by me to the Department under date of March 17, and the matter rested until the latter part of May, when I received a letter from the district attorney, in which he asked if I was taking any steps toward the collection of the information which he desired as preliminary to his plan of action, which in the same letter is described as being "to move at one time on every hydraulic mine in operation."

Under date of May 27 I replied that we differed as to the scope of our joint instructions in this matter, and that as under my understanding of them I had asked and received authority for certain engineering assistance in these cases, which would be quite unequal to the collection of information on the scale demanded by his plan, it would be necessary

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for me to again submit the matter to the Department for settlement. This I did in a letter, also dated May 27, in which I again described the existing dead-lock, referred to the impossibility of meeting the wishes of the district attorney with the means already sanctioned by the Department, and gave reasons for my belief that the plan of proceeding against all or most of the hydraulic mines in operation at one time was impractical and not contemplated in the original authority from the honorable the Secretary of War for action in the matter.

In reply, I am in receipt of a letter from the Department, dated June 29, with inclosures, one of which is a copy of a letter from the Attorney-General to the district attorney here, from all of which papers, taken in connection with previous correspondence, I infer that my views in this matter are approved.

During all these delays hydraulic mining, contrary to law, has been doubtless going on in many places, but in a small and intermittent way. Now, the dry season has probably suspended in great part these operations, and it would be of little use to try and collect the information upon which legal proceedings are to be based. The next few months will not be valuable time lost for this business; but it is desirable that before they are past some definite and practical plan of action under the law be decided upon and prepared for.

Up to June 30, 1886, there had been expended $255,607.24, of which $43,554 was for the building of snag-boat and barge, and $212,053.24 in actual construction upon the river and maintenance of plant.

During the year ending June 30, 1887, there was expended in work on the river $22,596.11, of which $2,735.94 was for repairs of snag-boat, and the remainder in the removal of snags, etc.

Besides the above named sum, $42,074.09 was expended in construction and outfit of dredge and $521.59 in the collection of information for proceedings against hydraulic mines.

Money statement.

July 1, 1886, amount available		$189,392.76
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$65,059.24	
July 1, 1887, outstanding liabilities	132.55	
		65,191.79
July 1, 1887, amount available		124,200.97
Amount that can be profitably expended in fiscal year ending June 30, 1889. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		40,000.00

STATISTICS.

The following statistics are furnished by Messrs. Thomas Dwyer and A. Foster, of Sacramento, Cal., for the fiscal year ending June 30, 1887:

By boats of Sacramento Transportation Company:

From San Francisco to Sacramento, merchandise	tons..	18,560
From San Francisco to Sacramento, lumber	do...	26,500
From San Francisco to Sacramento, coal	do...	4,200
From Sacramento to San Francisco, bricks	do...	51,000
From Sacramento to San Francisco, merchandise	do...	4,800
From San Francisco to Upper Sacramento River, merchandise	do...	14,500
From San Francisco to Upper Sacramento River, lumber	do...	11,600
From Sacramento to Upper Sacramento River, lumber	do...	1,250
From Sacramento to Upper Sacramento River, merchandise	do...	4,200
From Upper Sacramento River, wheat and barley	do...	64,650
From Upper Sacramento River, wool, broom-corn, and hay	do...	3,450
From Upper Sacramento River, wood	do...	26,400
From Upper Sacramento River, miscellaneous produce	do ..	3,250

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By boats of Southern Pacific Company:		
Between San Francisco and Sacramento (north)	tons..	39 .88
Between Sacramento and San Francisco (south)	do...	18, .98
By trading boat *Neponset:*		
From Sacramento to Upper Sacramento River, merchandise	do...	2,000
From Upper Sacramento River, wheat and barley	do...	1,000
From Upper Sacramento River, potatoes, fruit, and beans	do...	1,500
Total		296,146

STATISTICS OF TRADE ON THE FEATHER RIVER FOR FISCAL YEAR ENDING JUNE 30, 1887.

From San Francisco and Sacramento to Marysville and way landings:		
Hay	tons..	17.6
General merchandise	do....	6,344.8
Posts	number..	9,163
Laths	do....	246,000
Lumber	feet..	853,797
Shingles	number..	751.000
From Marysville and points on Feather River to San Francisco and way landings:		
Hay	tons..	100
Wool	do....	27.3
Broom-corn	do....	42.2
Grain	do....	4,522.4
General merchandise	do....	928
Hops	do....	40.8
Lumber	feet..	300,000

RECAPITULATION.

Freight, up and down	tons..	12,023
Lumber, up and down	feet..	1,153,797
Laths, up and down		246,000
Shingles, up and down		751,000
Posts, up and down		9,163
Money receipts for freight carried:		
Up		$22,504.64
Down		12,326.24
Total		34,830.88

S S 4.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

I was directed to take charge of this work by letter from the Chief of Engineers dated March 16, 1887.

The project adopted in 1880 had for its object straightening the upper part of the tidal portions of the river by three cut-offs between the lower limit of the town of Petaluma and the railway bridge, which shortened the channel to the length of 8,000 feet, and dredging in this distance to secure 3 feet in depth at low water to a width of 50 feet, all by contract.

Up to the period of my assuming charge of the work there had been expended the sum of $27,656.91, with the accomplishment of the channel sought in the original project. This work was finished in 1884, since which nothing has been done, and it is now believed that the dredged

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channel is almost entirely filled up, though the benefit given by the cut-offs still remains.

The tidal scour being insufficient for the removal of deposits from land drainage, must be assisted in the maintenance of the desired channel by repeated dredging.

A dredge having been built for the Government for use in the waters emptying into San Pablo and Suisun bays, the original project was, in March, 1887, modified to allow dredging by hired labor, to secure and maintain a channel with depths and limits as described in the original plan.

It is proposed with the sums available and asked for to carry out this modified project, and the work to this end being a recurring necessity, no estimate for final completion can be submitted.

Money statement.

July 1, 1886, amount available	$2,343.09
July, 1, 1887, amount available	2,343.09
Amount that can be profitably expended in fiscal year ending June 30, 1889, Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

S S 5.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

The project for this improvement was adopted in 1881, and had for its object to secure a channel 13 feet deep at low water and 200 feet wide to head of Eureka Wharves, with channels 10 feet deep at low water and 100 feet wide to Hookton and Arcata.

The project in 1882, after study by a Board of Engineers, was supplemented to seek the fixing in position and increase in depth the channel over the bar by a training-wall carried to low water and extending from the south spit in a northwesterly direction.

The last dredging in the bay channels was done in 1884, and on its completion the channels sought by the original project had been secured. In the lack of subsequent surveys the present condition of these channels cannot be precisely stated; but from the reports of the pilots it seems that the channel along the city front of Eureka and across the bar at the junction of Eureka and Arcata channels has reverted to its condition before improvement or possibly deteriorated.

The Eureka Channel has a sluggish current, besides receiving the sewerage of the town, and its maintenance with the dimensions to which it was enlarged in 1884 will require repeated dredging.

The act of August 5, 1886, provided that none of the money thereby appropriated for the improvement of the bar should be expended until the United States had obtained a title free of expense to the land desired on the South Spit, for which an exorbitant price had been demanded.

During September last I was notified that an arrangement had been made with the owners by those interested in the work, and requested to define by metes and bounds the tracts which would be necessary for our purpose. An assistant was accordingly sent to Humboldt Bay, who,

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having been appointed a deputy United States surveyor, made careful plats, connected with the land-office surveys of the land required above high water mark and the tide-lands adjoining the title to which was vested in the State of California.

An obstacle to the transfer of the upland was found in the existence of a minor heir owning an undivided one-sixth interest, and proceedings in the probate court here were necessary to empower the guardian to convey. This conveyance from the guardian, in accordance with the United States district attorney's wishes, was made to one of the other owners of an undivided interest, who will sign the deed to the United States.

Only during the past week was I furnished with an abstract of title completed to date, which has been submitted to the district attorney for examination, who, satisfied with the title, will prepare a form of deed for the approval of the Attorney-General.

At the last session of the State legislature an act was passed with the intention of conveying to the United States a title to the tide-lands, as described in the plat of survey by metes and bounds furnished from this office. By an unfortunate clerical error this description by metes and bounds was erroneously copied in the law and the patent, so that it does not describe any tract of land whatever, and effects, it is believed, no conveyance.

Since this discovery a proposition has been made that an application to the State for this tide land be made by some citizen who, on securing title, will reconvey to the United States; but the district attorney seems of the opinion that in view of the obvious intention of the legislature to dispose of the land in question no sufficient title to it could be obtained by private parties in advance of further legislative action.

If this be the correct opinion there seems no way in which the requirements of the act of August 5, 1886, for a clear title as preliminary to any expenditure can be satisfied until the next session of the State legislature has rectified the error of the existing law.

The channel over the bar in June, 1886, ran out nearly straight north-northwest with about 16 feet at high water, and kept in this direction and condition until the middle of October, when it began to shoal and work south. By the middle of November it was south by west, very narrow, and from 14 to 15 feet deep at high water. It remained with but little change until about the 1st of March, 1887, when its south channel closed and a new north channel began to open out nearly straight and deepening gradually. During June, 1887, it ran out straight west by south, with 16 feet at high water.

Money statement.

July 1, 1886, amount available	$62,363.64
Amount appropriated by act approved August 5, 1886	75,000.00
	137,363.64
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	748.33
July 1, 1887, amount available	136,615.31

Amount (estimated) required for completion of existing project	537,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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STATISTICS.

The following statistics for Humboldt Bay are furnished by the collector of the port and the Pacific Coast Steamship Company.

There are two steamers, each making regular weekly trips between San Francisco and Humboldt Bay; and during the past three months a third has been put on in opposition.

Statistics from only one of the regular steamer lines can be obtained; the business of the other is probably somewhat smaller.

During the year ending June 30, 1887, the number of vessels entered from foreign ports was	11
Number of vessels cleared for foreign ports	19
Value of exports	$113,711.00
Value of imports	$6,053.00
Amounts of duty collected	$2,040.12
Number of sailing-vessels sailed from this port, including those noted as foreign	496
The amount of lumber carried would average about (each) 275,000 feet.	136,400,000
Value of lumber about $18 per M	$2,455,200

Total number of sail-vessels registered and enrolled at this port are:

Class.	No.	Tons.
Steam-vessels	9	510.26
Sailing-vessels	9	2,009.69
Sailing-vessels under 20 tons	6	88.50
Total of district		2,608.45

The steamers of the Pacific Coast Steamship Company have carried on the route between San Francisco and Humboldt Bay—

	Tons.
Freight	24,946
Passengers	6,610

S S 6.

IMPROVEMENT OF THE COLORADO RIVER, NEVADA, CALIFORNIA, AND ARIZONA TERRITORY.

For reasons given in my last annual report no work was done upon the river during the year ending June 30, 1887, and no project is submitted or appropriation asked for the next fiscal year.

In care of property there was expended during the past year the sum of $180.46, and on September 1 the barge plant, and remaining supplies were sold at public auction, and the proceeds turned into the Treasury according to law.

Money statement.

July 1, 1886, amount available	$180.46
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	180.46

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S S 7.

PRELIMINARY EXAMINATION OF MOUTH OF SMITH'S RIVER, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 7, 1887.

GENERAL: In compliance with the instructions in Department letter of September 27, 1886, I have the honor to report as follows concerning the improvement of Smith's River entrance, California.

Smith's River is a small stream which rises in the coast range and after a course of some 25 miles in length empties into the ocean about 4 miles south of the boundary line between Oregon and California.

The tidal influence is felt about 4 miles above the mouth, and the tidal area of the estuary, including some connecting sloughs, is about 2.5 square miles.

In summer the fresh-water discharge is insignificant, and the depths across the bar are not more than from 3 feet to 4 feet, in a shifting channel; during the heavy winter rains the stream becomes a torrent, and the depths across the bar occasionally are increased to perhaps 15 feet at low water.

As is common with these entrances, the river spreads out into a lagoon behind the beach from which the exit to the sea is at the northern end, and close against a rocky headland. Of late years the bluff inside this headland at the north end of the lagoon has been encroached upon, and the southern sand point has advanced until now the channel inside passes among rocks and bowlders which formerly underlay the bluff, making the passage by vessels almost impossible.

An abortive attempt has been made by the persons interested to restore the original condition of affairs by a jetty of wooden caissons filled with gravel; and to do this in an effective way, by a training-wall 1,000 feet long, of riprap, raised to half-tide along the outer margin of the channel now encumbered with rocks, would cost about $100,000.

The effect of this improvement inside—on the bar channel outside—would probably not be appreciable, and we could expect to see it afterward, as now, offering, according to the season, depths of from 3 to 15 feet, in a constantly shifting channel. To effect a radical change for the better, it would be necessary, in addition to the training-wall as above described, to confine and direct the ebb across the bar by jetties projected into the open sea and exposed to its full violence in this stormy latitude.

It is believed that the cost of such works would not now be justified by the interests to be served. There is a saw-mill and salmon cannery near the mouth of the river, of which the former has a capacity of 35,000 feet, B. M., a day, and the latter packs some 6,000 cases and 500 barrels per year.

There is a large tract of timber and some good farming and grazing country tributary to Smith's River, but as navigation is only possible for a short distance above the mouth, the transport of the products of the upper valley there would not be much less costly than to the roadstead of Crescent City, where most of them now find an outlet.

In this connection is to be noted that a broad-gauge railroad now extends for some distance from the Crescent City wharf towards Smith's River Valley, and is used in bringing out logs, by the Crescent City Mill Company. The distance from the principal settlement of Smith's

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River to the Crescent City wharf is only about 8 miles over country offering no special difficulties, and it is lately proposed to extend this road to the valley, thus giving it an easy outlet to the sea.

I transmit herewith a tracing from the Coast Survey chart, showing the mouth of Smith's River and the location of the desired inside training-wall, also a copy of a report by Mr. A. Boschke, assistant engineer, who lately made an examination of the place.

Very respectfully, your obedient servant,

A. H. PAYSON,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF MR. A. BOSCHKE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
San Francisco, December 1, 1886.

SIR: I have the honor to report that I have made, in obedience to your instructions, an examination of Smith's River Harbor.

Smith's River is in Del Norte County. It discharges into the Pacific Ocean, about 4 miles south of the State line that divides Oregon from California.

The river rises in the Coast Range; its main branches are the North, Middle, and South Forks. The river proper has a length of 24 miles. The tides ascend the river to about 4 miles from its mouth.

Within this distance from the ocean the river proper and a number of sloughs form a tidal estuary of about 2.5 square miles. This estuary is separated from the ocean by a sandy peninsula of about a width of 500 feet, which terminates at a varying distance opposite a rocky headland, thus forming the entrance to a land-locked harbor. During the rainy season the freshets in the river scour a channel of ample width and an average depth of 15 feet at low water through the entrance between the rocky headland and the northern extremity of the peninsula. These freshets' discharges have caused to wear away a bluff within the rocky headland named Pyramid Point, exposing its rocky bottom, over which now the river and tidal water discharges, and has caused the end of the peninsula to encroach upon the ground where formerly an unobstructed channel was maintained by the combined action of the river discharge and tidal flow.

The present channel winds through the rocks and large bowlders of the rocky shelf, formerly covered by the abraded bluff, and is very dangerous to pass.

A jetty constructed of caissons filled with gravel has been placed at the upper end of the present channel by the owners of the saw-mill, who have about 2,500,000 feet of manufactured lumber at their wharf, which cannot be shipped at present on account of the dangerous obstructions in the channel.

The attempted improvement not having given the hoped for results, to direct the current to open the former channel now covered by the end of the peninsula, if a stone training-wall of riprap was placed on the outer line of the rocky shelf connecting with the bluff its inner end, and about 1,200 feet long raised to half-tide, it would restore the former condition, enabling the river and tidal currents deflected and concentrated by it to maintain a permanent, unobstructed channel of from 12 to 15 feet at low water between the training-wall and the northern extremity of the peninsula.

The outer bar is very narrow and lies close inshore. The concentrated current, directed by the training-wall and the steep bluff of Pyramid Point, would exert a scouring power as far out as the bar, and maintain a depth upon it of probably not less than 6 to 8 feet at low water.

Prince and King's islands are situated to the north of the entrance and adjacent to it, offering shelter from the northwest swells.

The estuary or harbor has a sufficient depth to float in safety the coasting vessels which can enter this port.

The following steamers and schooners have run for this port in the past, drawing, respectively—

Steamers:	Feet.
Mary D. Hume	10
San Vincente	9½
Continental	8
George Hawley	8
Alex. Duncan	9½
Tug Pelican	7

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Schooners:	Feet.
Sophia Bee	7
Anterlin	9
Challenger	7½
Sophia Wenger	9
Jas. Wooley	12
N. Van Bergen	8
Stranger	8½
Trucke	8
Sea Foam	10
Coquille	8½
Free Trade	8
S. Danielson	8½
Ester Cobas	7½
Helen Marriam	8
Anni Hermine	7½

The resources of the country, for which this port is the natural outlet, are—

	Acres.
Number of acres of redwood-timber land from Chetco to north bank of Smith's River	58,000
Belt lying contiguous to south bank	10,000
Red, white, and yellow fir, white cedar, myrtle, oak, etc	12,000
Total	80,000

The Del Norte Commercial Company's saw-mill has a capacity of 35,000 feet of lumber per day, and has manufactured during the last season 3,200,000 feet. Bailey's mill, run by water-power, and situated on Smith's River, 4 miles from the entrance, has a capacity of 10,000 feet of lumber per day. A. Gorman & Co., Shake Mill, 6 miles from the entrance, has a cutting capacity of 12,000 feet per day. The two latter mills both lying idle.

The amount of butter shipped annually from Smith's River Valley is 250 tons.

Total exports of produce during the past year is estimated about 700 tons, and the imports of merchandise about 1,400 tons.

There are extensive chrome mines situated in the low divide district, also a number of valuable copper mines.

The Tyson Smelting Company, of Baltimore, Md., shipped annually, from 1869 to 1873, 1,500 tons of chrome ore, hauling it on wagons through Smith's River Valley, 25 miles, to Crescent City.

In 1885 about 600 tons of ore was shipped by way of Smith's River. The salmon fisheries average 6,000 cases, and 500 barrels per year.

Estimate of cost of training-wall:

Length of wall, 1,000 feet; width on top, 10 feet; mean width, 85 feet; mean height, 15 feet. Stone in place: weight, 16 pounds per cubic foot, and allowing for voids one-third, 68,000 tons, at $1.50 per ton, $102,000. A ledge of rock about 100 feet in height is a vailable within a distance of 2,000 feet to obtain the rock for the training-wall in suitable dimensions.

Very respectfully,

A. BOSCHKE,
Assistant Engineer.

Capt. A. H. PAYSON,
Corps of Engineers.

SUPPLEMENTARY REPORT OF CAPTAIN A. H. PAYSON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., June 11, 1887.

GENERAL: Under date of January 7, 1887, I submitted to the Department a report on the proposed improvement of the mouth of Smith's River, California.

This report has caused much hostile feeling in the community interested in having work done at this point, and I am now in receipt of a letter from a Mr. O. V. Wallace, which calls attention to certain inaccuracies in my report, of which letter it seems only just to forward the inclosed copy for file with the papers in the case.

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The inaccuracies referred to are in the length of the stream itself, the depth on the bar, and the distance from the principal settlement in the valley to Crescent City Roadstead.

As regards the depth on the bar, it is shown on the Coast Survey chart as 4 feet, and it is merely an opinion whether it is ever less than this; so that in my report it would have been better to have given the minimum depth as 4 feet instead of 3 feet to 4 feet, as stated.

The length of the stream I quoted from the report of the assistant engineer who made the examination, and who, it seems, did not include the lengths of the three forks which unite to form the main river.

The distance from Smith River to Crescent City—given in my report as 8 miles—is really 16 miles, an error of my own which I regret, because, in connection with the rest of the report, it has been interpreted, perhaps not unnaturally, as evidence of a bias on my part in favor of Crescent City and against Smith's River.

The inconveniences of Crescent City Roadstead as a shipping point and the onerous charges of the wharf company are not overstated in Mr. Wallace's letter; and there is no doubt that the development of the Smith's River country will be hampered as long as Crescent City is to be depended upon as an outlet.

But the main points in my report of January 7, 1887, were that the construction of the proposed wall inside the mouth of Smith's River would require to be supplemented by costly works to seaward for control of the shoal and shifting bar channel before any substantial improvement could be had, and that, in my opinion, the expenditures necessary to that end were not now justifiable; and on these points I am not able to modify my originally expressed opinion.

I do not think, further, that it would be safe to expect to complete the inside wall for a less sum than that named in my original estimate.

Very respectfully, your obedient servant,

A. H. PAYSON,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

LETTER OF MR. O. V. WALLACE.

SMITH'S RIVER, CAL.,
May 10, 1887.

DEAR SIR: Pursuant to our mutual understanding while in your office at San Francisco I beg leave to submit to your notice and consideration the "memorial" that we forwarded to Congress asking Government aid for the improvement of the mouth of Smith's River, and ask your indulgence while I briefly review some of the points of your adverse report thereon and note the exceptions we have taken thereto.

You say: "Smith's River is 25 miles long." The North Fork is 22 miles long, the South Fork is 24 miles, and the Middle Fork is 12 miles long, and these branches uniting form the river proper, which is thus 25 miles long. You place the depth of water on the outside bar in the summer-time at "from 3 to 4 feet," while the shallowest measurement of which we have any record places the depth at 4 feet.

Besides, of all the vessels that have ever entered and departed from the mouth of the river not one has ever found the bar too shallow; in fact, we have never had the slightest degree of trouble arising from the bar.

The trouble is within the mouth of the river, where the sea has driven the current back over a rocky bed that cannot wash out, nor the channel be otherwise deepened (save at an enormous expense), and is thus rendered unnavigable.

What we ask is that the proposed training-wall be constructed so as to drive the sea back and restore the bed of the river to its original condition, in its natural channel. It was in that condition and channel for a number of years, and while so there was an abundant depth of water, and while in such condition sailing-vessels sailed in and out of the mouth without other aid with perfect impunity.

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Do not these facts, then, successfully and effectually dispose of the argument against the construction of the proposed training-wall as far as the outside bar is concerned? And there remains only its estimated cost, which may be greatly reduced in view of the fact that not over one-third of its length is exposed to the action of the sea. Therefore we simply ask a restoration of that condition, which it is admitted the proposed wall will effect.

Your report places the distance from Crescent City Wharf to the principal settlement of Smith's River at about 8 miles, while the actual distance is just double that figure—16 miles. You sum up: "It is believed the cost of such works would not now be justified by the interests served."

In rebuttal we would respectfully ask your careful perusal of the accompanying statistics, and also the memorial inviting your particular attention to its introductory, the scope of country represented by the petitioners, the affidavits and the letter of transmittal, the press comments, the supplemental memorial of masters and owners of vessels, and especially the supplemental memorial of the principal business firms of San Francisco, under their own signatures.

You are already aware of the fact that there is no harbor between Humboldt Bay and Port Orford, a distance of hundreds of miles, the Crescent City landing being neither safe nor reliable, vessels lying at the wharf being compelled to put to sea in case of storm or even a rough sea running. No longer ago than the 7th instant the schooner *Wing and Wing* was loosed from her moorings and driven ashore at that place, where she now lies on the beach. At the same date the steamer *Crescent City* made her appearance, but put to sea again without so much as landing her passengers, who were compelled to remain on board till yesterday, when they were finally landed, and the steamer, without discharging her freight, or any portion of it, immediately put to sea again, where she is now cruising about, awaiting a favorable chance to come to the wharf; and this is not an exceptional instance, but has been repeated time and again, especially during the winter season, sometimes lying out a week or more.

Do you think the outlook for our intercourse and traffic with the outside world very encouraging in the face of these facts, even should the "broad-gauge railroad" that you allude to in your report as the sovereign panacea for our pent-up longings be extended across the river and into our valley?

Besides, the Crescent City Wharf monopoly has always compelled shippers to pay a heavy tribute, the wharf charges being exorbitant, in some instances greater than the cost of transportation of the article by steamer the entire distance from San Francisco; so even in the event of the completion of said railroad the situation, as far as shipping facilities are concerned, will be but little improved.

We ask a careful consideration of these facts, and trust they may be potent enough to induce you to recede from the adverse opinion you have held in reference to the proposed "Smith's River improvement," and pray that you may see fit to so correct or modify your report as to render it favorable instead of unfavorable, and that we may obtain what we so much stand in need of—a good, permanent, and reliable shipping point right at our own doors, and which has been aptly and correctly characterized by Mr. Boschke as "the natural outlet for this section of country."

Begging pardon for intruding to such an extent on your time and patience, and asking at your hands a careful consideration of the merits of the case, and that you will preserve and return the inclosures at your convenience (either direct or through Mr. Deming), and that I may have the pleasure of receiving at an early date a favorable reply,

I subscribe myself, yours, truly,

O. V. WALLACE.

Captain PAYSON,
Corps of Engineers.

S S 8.

PRELIMINARY EXAMINATION OF CRESCENT CITY HARBOR, CALIFORNIA, WITH A VIEW TO A SEA-WALL FROM BATTERY POINT TO FLAT ROCK.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 19, 1887.

GENERAL: In compliance with instructions contained in the Department's letter of October 28, 1886, I have the honor to report as follows concerning Crescent City Harbor, California, with view to a sea-wall from Battery Point to Flat Rock.

Flat Rock lies about 1,000 feet from the mainland at Battery Point, and in about 2 fathoms at low water. Between the point and the rock

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in a reef which goes almost bare at low water, and which formed the support of the old wharf, now carried away.

A new wharf has been built to the north and east of the old one, as approximately shown on the chart herewith; and should the sea be prevented by a wall from breaking across the reef between the point and Flat Rock, some additional protection would doubtless be given the new wharf.

Owing to the slight depth of water in which the wall as contemplated in the act would have its outer end, it would not when completed appreciably improve the shelter now naturally afforded to the anchorage, and from its faulty direction it would be useless as the starting point of a breakwater designed to afford a radical improvement should such a measure ultimately be decided upon. The cost of the work would be about $140,000, but for the reasons above given I should recommend that if any work be undertaken for this harbor it be directed to the construction of a wall between the Light-House Island and Steamboat Rock. Such a wall would give in itself a valuable addition to the existing shelter and form part of any general plan for making the roadstead secure in all weathers for a small number of vessels.

The cost would be in the neighborhood of $1,500,000 for the wall carried to Steamboat Rock, and this would probably make it safe for one or two small vessels to lie in the roadstead in all weathers at properly laid permanent moorings. The commerce benefited would be local only, for reasons fully set forth in the report of the Board of Engineers on Harbors of Refuge (Report of Chief of Engineers, 1881), showing the unfitness of Crescent City Harbor for a general refuge for Pacific-coast commerce.

Admitting that the local commerce is important enough to justify some expenditures for its better protection, I am not prepared to believe that a work of such magnitude as will alone effect a material improvement is now warranted by the circumstances of the case.

Sufficient data is already available for a detailed project without further survey or examination.

This report has been withheld in the hope of procuring detailed statistics of the last year's business of Crescent City Harbor, for which repeated application has been made since early last December. These statistics have not yet been received, so I deem it best to forward my report without them and furnish them later should they be obtained.

Very respectfully, your obedient servant,

A. H. PAYSON,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

STATISTICS OF TRADE FOR NINE MONTHS ENDING DECEMBER 31, 1886.

Lumber	feet..	16,895,000
Assorted merchandise:		
Up	tons..	3,500
Down	do...	1,529
Passengers by one steamer:		
Up		653
Down		543

Passengers were also carried by schooners and by two other steamers which visit the port, but no accurate account could be obtained as to the number.

During several years preceding, the last shipments of chrome have averaged 3,000 tons per year, but the discovery of other mines in southern California have for the present suspended the business.

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APPENDIX T T.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY; OF THE ENTRANCES TO COOS AND YAQUINA BAYS; OF MOUTH OF COQUILLE RIVER AND OF UMPQUA RIVER, OREGON; AND OF CERTAIN RIVERS EMPTYING INTO PUGET SOUND AND GRAY'S HARBOR, WASHINGTON TERRITORY; CONSTRUCTION OF CASCADES CANAL, COLUMBIA RIVER; WATER-GAUGES ON COLUMBIA RIVER.

REPORT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mouth of the Coquille River, Oregon.
2. Entrance to Coos Bay, Oregon.
3. Umpqua River, Oregon.
4. Entrance to Yaquina Bay, Oregon.
5. Mouth of the Columbia River, Oregon and Washington Territory.
6. Construction of canal at the Cascades, Columbia River, Oregon and Washington Territory.
7. Chehalis River, Washington Territory.
8. Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers, Washington Territory.
9. Gauging waters of the Columbia River and principal tributaries, Oregon and Washington Territory.

EXAMINATIONS AND SURVEYS.

10. Suislaw River and Bar, Oregon.
11. Nehalem Bay and Bar, Oregon.
12. Coquille River between Coquille City and Myrtle Point, Oregon.
13. Umpqua River, Oregon.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, August 1, 1887.

SIR: I have the honor to send herewith annual reports upon river and harbor improvements under my charge for the year ending June 30, 1887.

On the 9th of October, 1886, the charge of improving the Columbia River at the Cascades was transferred to me by Maj. W. A. Jones, Corps of Engineers.

* * * * * * *

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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T T 1.

IMPROVEMENT OF THE MOUTH OF THE COQUILLE RIVER, OREGON.

The plan is to build a half-tide jetty or deflecting dike, about 3,400 feet long, from the left bank, inside of the old mouth, directed about magnetic west and passing 800 feet south of Rackliff Rock, for affording a channel to the sea through the former north cape and 10 feet deep at mean lower low water. The mean rise of tide above the reference plane is 4 feet. The original estimate of cost is $164,200. The amount expended on the project is $37,989.35.

Jetty extension, under the appropriation of 1884, was closed in April, 1885. The structure built to that time is 1,523 feet long.

The old channel was long, tortuous, shoal, and rendered extremely dangerous by numerous rocks. Captain Floyd, of the bar tug, states that he used 23 buoys to mark submerged rocks inside of the old entrance; exposed rocks existed both inside and outside of the entrance.

The channel projected by the improvement was opened four years ago, or two years after the jetty was begun, and has since been maintained with but little variation in position and depth. This channel is short, direct, free from dangerous rocks, and 6 feet deep at low tide, or about double the former depth.

From September to December, 1886, under the appropriation for that year, eleven compartments of outer close piling, previously left incomplete, were strengthened by framing and screw-bolting 8 by 8 inch timbers to the walls; 1,040 feet of tramway on bents were built to a quarry rock, and about 5,000 cubic yards of stone quarried and placed in the compartments to compensate for settlement, or placed at the foot of the bents of the quarry tramway. The drilling of the rock awash near the new channel and abreast of the middle part of the jetty was continued, twelve holes now having been sunk of an aggregate length of 120 feet. A high deposit formed around the rock, so its blasting was deferred until it might be again uncovered.

Operations were resumed in May. The quarry was cleared; a boom for piles built at the outlet of the lagoon near the jetty, and an elevated track therefrom, 605 feet, over the old jetty, to the shore end of the close-piled work; also a storage platform, 16 feet by 45 feet, and an incline pile-way 40 feet at the boom; the pile-driving car was set up with new trucks, gins, and engine, and a jetty advance of 103 feet, well ballasted with stone, secured by the end of June. This makes the work to that time 1,626 feet long. The close-piled walls of the new structure are 7.5 feet apart between their middle lines, instead of 6 feet, and the cross-walls 50 feet, instead of 20 feet as in the former piled jetty, whose construction is described in the report for 1885.

The work is being pushed out as far as practicable and some perishable material used, on account of an urgency for channel improvement, to the temporary prejudice of the profile of full strength. There is need of the full depth intended by the plan.

The jetty should be extended to the projected length and then made permanent by heavy ballast and riprap; a short jetty on the north side is also required. The amount estimated for next year is for application to these ends.

The satisfactory improvement effected at the mouth of the Coquille River has been of benefit to the traffic of the valley and tributary coast by materially reducing vessel insurance rates and freight charges.

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Superintendent R. S. Littlefield has continued on this work, and given his good services to its successful prosecution.

APPROPRIATIONS.

Act July 14, 1880	$10,000.00
Act August 2, 1882	10,000.00
Act July 5, 1884	10,000.00
Act August 5, 1886	20,000.00
Total	50,000.00

Money statement.

July 1, 1886, amount available		$197.87
Amount appropriated by act approved August 5, 1886		20,000.00
		20,197.87
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$10,119.94	
July 1, 1887, outstanding liabilities	3,397.53	
		13,517.47
July 1, 1887, amount available		6,680.40

Amount (estimated) required for completion of existing project	114,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The mouth of the Coquille River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the port of entry. The nearest light-house is on Cape Arago, 12 miles northward.

The principal industry of the valley is lumbering; the timber is a good quality of fir, white cedar, spruce, ash, and myrtle. A fleet of schooners carries the product to San Francisco, and brings back supplies. There is some vessel-building on the river. The upper part of the valley is agricultural. The dairy and grazing region, half way south to Port Orford, finds an outlet at the mouth of the Coquille. Coasters ascend to Coquille City, 28 miles, and the river is navigated by light-draught vessels 12 miles further.

Captain I. Parker, of the Coquille Mill and Tug Company, wrote January, 1887, that "before any improvements had been made by the Government, and up to that time, we paid from $9 to $11 per M on out cargoes of lumber, and from $7 to $10 per ton freight on merchandise brought in the river.

"At that time the only vessels that could safely navigate the bar were of not over 100,000 capacity, and often would be bar-bound from fifteen to sixty days for want of depth of water on the bar. These vessels did not draw over 7 feet when loaded.

"Since our bar has been improved we have vessels running successfully, carrying out from 180,000 to 215,000, drawing up to 8 feet 8 inches.

"The present rates on lumber are $4.75 per thousand, and about an average of $3 on merchandise per ton. We have paid no insurance on anything since the channel over the bar has been straight out. I believe those that do insure pay about 60 per cent. of what was formerly paid.

"The interest on money invested in vessels and through quicker dispatch has been reduced one-half by the improvements."

Similar statements were made by R. H. Rosa, esq., Averill & Dyer, merchants, and others.

The following, furnished by Mr. Zachry T. Siglin, deputy collector, refer to the Coquille River, and are for the year ending June 30, 1887:

Value of domestic imports, $210,000; exports, $391,000; coastwise arrivals, 33; clearances, 34; registered tonnage, 6,734.55 tons; new vessel on ways, 1; estimated tonnage, 9 tons.

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Record of bar crossings.

[Compiled from monthly vessel reports, Engineer Office.]

Draught.	July 1 to June 30—				
	1882–'83.	1883–'84.	1884–'85.	1885–'86.	1886–'87.
Not given	34	3	.....	4	15
7 feet and less	6	38	16	28	25
7 to 8 feet	14	24	13	13	12
8 to 9 feet	3	7	8	10	21
Total	57	72	37	55	73

T T 2.

IMPROVEMENT OF THE ENTRANCE TO COOS BAY, OREGON.

The plan is to build a half-tide jetty or deflecting dike about 2,400 feet long from near Fossil Point, inside of the entrance, on a slightly curved line towards Coos Head, exterior to the entrance, for affording a direct channel of 14 feet depth at mean low water, and one less exposed to heavy seas and of easier access under storm winds than the ordinary natural channel. The mean rise of tide is 5.6 feet.

The total appropriation is $163,750. The amount expended on the present plan is $132,101.69. The original estimate of cost is $600,000.

Jetty work was last closed, from want of sufficient funds, in December, 1884. This structure, built as described in the previous report, measures, from about high-tide line to the foot of the end slope, 1,825 feet.

The approved project for applying the appropriation of 1886, $33,750, consisted principally in quarry operations, retaining $31,000 until its use might appear judicious. The appropriation recommended, $160,000, was for continuing the jetty by working from land and for expense of dump-scows, tug hire, and laying a foundation course in advance. The small amount appropriated did not warrant the application of both these methods of work.

The quarry operations were conducted last winter; they consisted in considerable betterments to the water supply, in sluicing the material overlying the rock, and in clearing the quarry for advantageous use when adequate funds should be provided. Sufficient stone is now conveniently exposed for such use.

Subsequently a proposition, not yet acted upon, was submitted for applying the remainder of the present appropriation. I insert an extract from this project, since it describes the condition of the jetty and gives its history:

The sea end of the work, as shown on the chart accompanying the approved project of a Board of Engineers, 1879, for applying the first appropriation, is about 900 feet distant from the end of the present jetty.

The statement of the projected length of 2,400 feet is derived from the Annual Report of Chief of Engineers, 1881, which says that it is expected a further extension of 1,000 feet will maintain a depth of 19 feet at high water, and that the appropriation asked for is to make part of that extension. Of this extension of 1,000 feet about 600 feet remain to be built. It is not probable that the balance proposed now to be applied will build a bottom course of the cross-section named of over 400 feet.

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Except the first section of the present jetty, which is of timber cribs ballasted with stone, the method of construction has been to make an enrockment by dumping stone from an elevated tramway over the jetty. The stone for the enrockment was conveniently quarried at the land end of the jetty, but the piling of the tramway was subjected to considerable damage by sea and drift during winter and by the *teredo;* and, notwithstanding that the dump was kept as low as practicable, extensive scour occurred ahead of the work.

Starting from about the high-tide line the top of the jetty inclines to low water at a distance of 700 feet; then is nearly level, averaging a low-water depth of about 2 feet, and then inclining again to a low-water depth of 13 feet at a distance of 416 feet, beyond which is the end slope of the enrockment. The foot of the slope is in 10 fathoms; ahead the water is deeper by 2 to 4 fathoms; then the bottom shoals to the north cape about 1,000 feet from the jetty measured on its prolongation.

The jetty's intended work is to deflect the outflow in a manner to oppose a persistent growth of the north spit and to project the ebb normally against the bar and direct the channel into the outer harbor, where the seas are not so heavy and the storm winds are fair and leading into the bay.

In the natural condition of the entrance the outflow, following the east side of the lower bay to the mouth of the south slough, was forced to double on itself in rounding the north spit, then to make a long run north near the west face of the north spit and north cape, finally escaping northwesterly to the sea, where the crossing was opposed to the heavy swells and in a direction which made the storm winds unfavorable.

The causes of this channel condition were the southern growth of the north sands, the configuration of the northeast face of Coos Head, and the westerly seas.

Upon the first considerable jetty construction erosion of the north spit was plain. After the first winter the north bar channel had moved south about one-half towards the intended position; at no time has it gone back to the north, although it has shifted back and forth a little and changed depths somewhat. Commencing in October, 1885, the improvement has been more decided, both in degree and apparent permanency.

My views on the conditions at Coos Bay, together with statements of the channel improvement effected, are more fully given in the last annual report.

It appears to me that the theory of the plan of improvement is good. The result so far is certainly beneficial, but I judge that the full improvement of which the entrance is capable by the present plan will not be attained until the outflow is deflected so that it will not cross the jetty alignment. I do not see that one can tell what length of jetty will just secure this, nor any fixed degree of channel improvement. Channel depths since October, 1885, have ranged from 12 to 16 feet at low water. The depth actually required by present Coos Bay vessels is a sure 14 feet at low water, and a further improved channel location is important.

The expense incurred by the building of the last section of the enrockment, 72 feet, was $417 per foot; about 50 per cent. should be added to bring the crest of this part to half tide. At the resulting rate the 600 feet remaining of the projected length, together with the probable cost of raising the present jetty, comes so near the estimate for completion of the present project borne in money statements of annual reports of late years, and now $436,250, that I do not see any need of changing that estimate.

The proper way to execute the work is to keep a foundation course in advance 300 or 400 feet long and follow it by a low dump from land; and then wherever the jetty of full height terminates to raise the advanced part so that its top will incline from low water at the rear end to near the bottom at the sea end.

The jetty work can now be advantageously completed in two years. The estimate for next year, $220,000, is for the advanced foundation course, to follow it by a low dump from land and to bring the present part to low tide. In the following year the whole length should be completed and the top and exposed side of the work faced with larger and harder stone than now used.

APPROPRIATIONS.

Act of March 3, 1879	$40,000
Act of March 3, 1881	30,000
Act of August 2, 1882	30,000
Act of July 5, 1884	30,000
Act of August 5, 1886	33,750
Total	163,750

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Money statement.

July 1, 1886, amount available		$538.25
Amount received by transfer of property to other improvements		583.50
Amount appropriated by act approved August 5, 1886		33,750.00
		34,871.75
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$3,842.44	
July 1, 1887, outstanding liabilities	118.89	
		3,961.33
July 1, 1887, amount available		30,910.42
Amount (estimated) required for completion of existing project		436,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		220,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

COMMERCIAL STATISTICS.

Coos Bay is in the collection district of southern Oregon. Empire City, on the bay, is the port of entry. The nearest light-house is at Cape Arago, on the south side and west of the entrance.

The following refer to the year ending June 30, 1887, and were furnished by Zachry T. Siglin, deputy collector:

Value of domestic imports, $152,230; exports, $550,890; coastwise arrivals, 186; clearances, 190; registered tonnage, 123,847.26 tons; new vessels built, 4; registered tonnage, 270.14 tons; new vessels on ways, 1; registered tonnage (estimated), 115 tons.

During the last four and a half years the improvement has afforded a straighter and more stable channel than formerly existed, and during the last twenty-one months a deeper channel, and one partly protected from the heaviest seas. These results have decreased bar detentions and permitted vessels to make more trips and to load to fuller capacity, and have also permitted the sailing vessels to add 6 inches of shoe, increasing their actual draught by that amount.

The principal shipments, and which are made to San Francisco, are lumber, coal, and wooden manufactures; salmon, furs, barks, potatoes, and other articles are also shipped. General merchandise and supplies are brought by the vessels on their return trips.

The vessels loaded draw from 12 to 14 feet. The coal trade competes with that of Puget Sound, whose vessels draw 18 feet or more. The lumber trade also contends against that of the Sound and other coast places, some larger and some smaller than Coos Bay.

The collector of customs of the Coos Bay district writes, January, 1887, that "the result of the jetty so far has been a marked reduction in freight charges, by reducing time of transportation; also a reduction of insurance risks by rendering navigation safer.

"By the reduction of freight charges there has been a saving to the lumber manufacturers of Coos Bay during the last year $21,000, this amount representing a reduction of $1 per 1,000 feet of lumber. The saving to the owners of coal mines by reduced freights has been $36,000 during same period. Other industries are benefited in like proportion.

* * * * * * * *

"It is safe to predict that by maintaining a good harbor on Coos Bay ship-building will grow to be one of its leading industries, as the timber of the section and adjacent to the bay is highly adapted for ship-building purposes. During the year 1886 there have been built on Coos Bay the steamers *Cruiser*, *Traveler*, *Antelope*, and *Butcher Bay*, and the sailing vessels *Alton* and *Spy*, aggregating tonnage 31,684.

"During the six months ending December 31, 1886, the number of vessels arrived at Coos Bay have been 110, with an aggregate tonnage of 42,255.95, clearance 107, aggregating tonnage, 40,328.66."

Mr. G. A. Bennett, of Marshfield, Oregon, after consulting with leading business men of that place, finds, January, 1887, as resulting since the jetty commenced, "(1) Freight rates between this port (Coos Bay) and San Francisco have been reduced one-half; (2d) towage on vessels has been reduced nearly one-half, mainly due to the fact vessels take heavier cargoes than heretofore; that insurance on vessels to this port is 2 per cent. less than to other bar harbors on the coast, and that since the improvement has made itself felt no vessel has been wrecked, or even injured, while crossing in or out of the bay."

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The superintendent of the Newport coal mine, Coos Bay, writes, that "the commercial benefit of the jetty work at the entrance to Coos Bay has resulted in reducing transportation charges on coal from $5 to $2.30 per ton.

"Steamers and sailing vessels are seldom, if ever, detained, and the steamers ply with regularity, thus enabling our company to keep a constant supply of coal in San Francisco, which was impossible before the jetty was commenced."

Capt. G. A. Holt, steam-ship *Arago*, states that "the cost of transportation on merchandise, coal, and all freight handled by steamers plying to this port has, within the past year (1886) been reduced 50 per cent.; the tariff on passengers 33⅓ per cent.

"How much, if any, the insurance on cargo has been reduced I am unable to state, but on tonnage the rate is as low as at any port on the coast. The steamer *Arago*, insured especially for this trade, is insured for $110,000, at 7 per cent., as against 10 and 11 per cent. paid by tonnage two and three years ago.

"Regarding reductions of interest, I should place it at 50 per cent. These figures relate entirely to the steam-ship business at this port, but if data be obtainable from the sailing fleet, I think it would show about the same set of figures.

"For the year ending January 6, the *Arago* has completed 41½ round voyages between Coos Bay and San Francisco, against an average of 26 round-trip voyages made by steamers before the bar improvement."

T T 3.

IMPROVEMENT OF UMPQUA RIVER, OREGON.

The plan is to apply the balance of the appropriation of the act of March, 1871, in rock removal at five reefs near and below Scottsburgh, the head of navigation, for a channel 3 feet deep by 50 feet wide, at low water, with a view to aid navigation by small screw-vessels. The balance of funds was $4,685.89; the amount expended thereof is $4,671.85.

The controlling natural depth on the reefs was 1 foot at low water. In 1885 four of the reefs had been drilled and blasted, the fifth reef drilled, and the channel marked by range stakes.

The work of removing the broken rock and some minor operations were prosecuted during July and August, 1886, by a party under the superintendence of Assistant-Engineer J. S. Polhemus, who reported:

We worked at Reef 1 thirteen days, and removed about 26 small scow loads, which I should think would average 8 tons apiece. After the work we left a channel on Reef No. 1, 50 feet wide, with a controlling depth of 2 feet at zero of tide-gauge, with many deeper holes formerly occupied by large pieces of stone.

The remaining obstruction to a 3-foot channel consists chiefly of a bank of small fragments of stone, coarse gravel, and sand, perhaps in some cases covering a large piece.

The broken rock on Reef No. 2 was nearly awash at zero of gauge when we commenced to grapple, some pieces even projecting above.

Eight scow loads were removed, and some large pieces dragged into deep holes.

The cut through Reef No. 2 was left with a controlling depth of 2 feet in a channel 50 feet wide at zero of gauge.

Five scow loads were taken from Reef No. 3, and some large pieces dragged into deeper water.

There is now a controlling depth in 50-foot channel of 2½ feet at zero of tide-gauge.

A few of the larger pieces on Reef 4 were broken up by surface blasting, but no stone was grappled up.

Reef 5 was not blasted. As it is the steamboat can pass to the south of these reefs with more water than is now in the cuts on the lower reefs.

The steam-drill was fitted up and four holes drilled, and the buoys, prepared last year, placed on the south edge of the cuts on Reefs 1, 2, 3, and 4.

The saplings placed to mark cuts last year were found in position.

About 200 pounds of powder (No. 1) was used in surface blasting, and three large pieces of rock near the Scottsburgh wharf were removed.

Reef No. 5 was not blasted, as funds remaining would not pay for clearing the cut, and merely blasting the rock would have made more

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of an obstruction than naturally existed; the reef is not so high as the other reefs were and was purposely left until the last.

The controlling natural depth at the reefs has been increased 1 foot. This part improvement permits the mail-tug to leave Scottsburgh about two hours earlier on flood tide.

The work of removing broken rock was more expensive than expected. The estimate for completing the present project has been increased accordingly.

A preliminary examination of the Umpqua was made in compliance with the act of August 5, 1886, and a report submitted January 31, 1887. It was therein estimated that $30,000 are required for contraction works at two bars, removal of some bowlders, and work additional to that of the present project on the Scottsburgh reefs, in order to afford a needed 4 feet low-water channel below Scottsburgh.

APPROPRIATION.

Act March 3, 1871, Umpqua River, Oregon	$22,500.00

Money statement.

July 1, 1886, amount available		$720.53
Amount received by transfer of property to other improvements		162.80
		883.33
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$931.76	
July 1, 1887, outstanding liabilities	44.99	
		976.75
Amount (estimated) required for completion of existing project		2,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1886 and 1867.		

COMMERCIAL STATISTICS.

Umpqua River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the nearest port of entry. The nearest light-house is at Cape Arago, entrance to Coos Bay, about 22 miles south.

The river below Scottsburgh is a port of a tri-weekly mail-route from Drains on the Oregon and California Railroad to the lower river district, and by the coast north to the lower Siuslaw country and south to the Coos Bay region.

The wagon road from Drains to Scottsburgh is 30 miles, while the distance to navigable waters on the mail-routes, from the interior towards the coast, next north and south of the Umpqua route, is about 60 miles.

For four years at least the mail boat on the Umpqua has been a small tug, necessarily drawing more than stern-wheel steamers, with which it was formerly expected to navigate the upper river. The mail-tug draws 4 feet, carries passengers and express, and tows a scow for carrying freight. The tug is more economical than a stern-wheel boat, and adapted, which the latter would not be, for service near the mouth of the river where there are two mail landings. There is another steam-craft working on the lower river and generally used in towing logs. A bar-tug is stationed at Gardiner, near the river mouth, which has, however, no special cause for going above.

There is a tannery at Scottsburgh, whose product is shipped to San Francisco. Farm products are also taken down the river to supply the logging-camps and Gardiner, where there is a large saw-mill, which maintains a lumber trade, by vessel, to San Francisco.

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T T 4.

IMPROVEMENT OF THE ENTRANCE TO YAQUINA BAY, OREGON.

The plan is to build a high tide brush-mattress and stone jetty, about 4,000 feet long, on the south side of the entrance, to close a rock-obstructed channel, for providing a central free channel of increased depth. Shore protection on the entrance side of the jetty was contemplated. A shorter jetty from the north reef, approaching the adopted work to about 1,000 feet, was proposed for future consideration. The channel depth to be obtained was placed in 1881 at not less than 17 feet, and subsequently until the present time at not less than 19 feet, mean high tide.

The total appropriation is $235,000; the amount expended on the present project is $184,878.20. The original estimate of cost is $465,000. A revised estimate, including the cost of a north jetty to supplement the present project, was presented in the report of 1886.

Jetty extension was stopped June, 1885, from want of funds; the part built measures 2,517 feet, exclusive of 450 feet of heavy shore protection; the outer portion of the jetty was not brought to full height.

For a better consideration of the proposition of the extension of the Yaquina project for affording a deeper channel than intended by the present project, and under the appropriation of 1886, the entrance was surveyed; a series of observations of the currents at and off the entrance taken; the tidal volume of the bay measured and extended borings made on the bar to better determine the elevation of the hard bottom. These works were prosecuted with difficulty because made in the stormy season, and necessarily so, in order to prepare in the spring for jetty operations.

From a study of the results obtained, and of previous ones, a project was offered and approved for applying the remainder of the appropriation. This consisted in extending the jetty on a certain line 600 feet, and in observing the effect thereof on the bar movement as controlling further extension. As this project gives the results of the surveys and observations, and supplements the history of the entrance given in the last report, the project is appended hereto.

The Yaquina appropriations had been small. The plant used heretofore was inadequate for more extended work, and now partly worn out. The wharf piling was badly weakened by *teredo* and the stone-scows and caps and stringers of the tramways by decay. A small locomotive and irons for larger and better dump-cars were purchased in the East, cars set up at the work, and other betterments and repairs made to the plant. Contracts were made for stone, piles, and sawed timber. Actual jetty operations were commenced in the latter part of June by the receipt and dumping of stone in low places on the old jetty. Four hundred and thirty tons were delivered and placed. Barring some delay on account of failure in the stone delivery and a necessary change in the contract, there is every promise of a satisfactory progress on the jetty during the summer and fall.

A small survey of the bar channel was lately made, and is shown on a progress map herewith. The very good depth of 20 feet at mean high tide was found. It should be noticed, however, as explained in the histories of the entrance, that spring and early summer are the times of the better channel under natural conditions; and, on the other hand, that the new depth is greater by 1 foot than the best heretofore observed during the same seasons.

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Assistant Engineer J. S. Polhemus has been connected with the work this year, as before, as chief of party on the surveys and as local superintendent of construction. Any merit which may attach to the Yaquina work is greatly due to his assistance.

APPROPRIATIONS.

Act June 14, 1880	$40,000
Act March 3, 1881	10,000
Act August 2, 1882	60,000
Act July 5, 1884	50,000
Act August 5, 1886	75,000
Total	235,000

Money statement.

July 1, 1886, amount available		$1,637.73
Amount appropriated by act approved August 5, 1886		75,000.00
		76,637.73
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$29,778.30	
July 1, 1887, outstanding liabilities	4,382.59	
		34,160.89
July 1, 1887, amount available		42,476.84
Amount (estimated) required for completion of existing project		96,970.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing and delivering, on Government scows, 20,000 tons stone.

Number.	Names and addresses of bidders.	Quarry.	Price bid per ton of 2,000 pounds.	Delivery.	Price per ton at 1 cent per ton per mile towage to Government wharf.	Amount of bid.
1	Hoffman & Bates, Portland, Oregon	Cannon quarry	$0.60	Cannon quarry	$0.74	$12,000
2	M. S. Hart, Portland, Oregon	....do	.63	....do	.77	12,600
3	Silas Wilcox, Portland, Oregon	....do	.75	....do	.89	15,000
4	Patrick O'Neil, Portland, Oregon	....do	.75	....do	.89	15,000
5	Wiberg & Johnson, Portland, Oregon	....do	.54	Not stated	.68	10,800
6	Bates & Steel, Portland, Oregon	....do	.52	Cannon quarry	.66	10,400
7	Ralph Ingham, Newton, Oregon	....do	*.48	....do	.62	9,600
8	Keady & Fordyce, Portland, Oregon, Yaquina City, Oregon.	Not stated	1.15	Jetty wharf	1.15	23,000

* Accepted.

Abstract of contracts.

No.	Name and address of contractor.	Contract.		Remarks.
		Date.	Subject.	
1	Ralph Ingham, Newton, Benton County, Oregon.	May 9, 1887	Furnishing 20,000 tons stone on Government scows at Yaquina River.	Contract assumed by bondsmen July 16, 1887, contractor failing.

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PROJECT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, April 6, 1887.

SIR: Referring to my last annual report upon the improvement of the entrance to Yaquina Bay, Oregon, and to the letter of Colonel Mendell, August 20, 1886, concerning that work; also to the preliminary project for applying the present appropriation, printed copies of which papers are inclosed, I have the honor to report upon the results of the surveys made for fulfillment of that project and to recommend a project for applying the balance on hand.

A hydrographic survey of the entrance, a tracing of the map of which is herewith, was made in September, 1886. Two channels were found (a south central and a south), having low water depths of 7 and 8 feet and distances between 12-foot curves of 1,000 and 1,100 feet respectively. This represents the generally usual channel condition after the northwest winds of summer have prevailed. By February the two channels had been replaced by a single channel, about midway between their locations and of 11 to 12 feet depth, the north spit then extending from shore, quite shoal, with no channel through it, to a point 2,200 feet in advance of the jetty and about on its alignment.

Probably further southerly storms will force this channel north to a central position, according to the usual channel changes, depending upon the seasons, and described in my annual report.

There are now three surveys, one in August and September, 1880, before the jetty was commenced; one in June, 1885, after the present jetty was built and the last survey.

Comparing the surveys of 1885 and 1886, it may be seen that the inside 12 and 18 foot curves have pushed out about 900 and 1,400 feet respectively, while the channel depths and outer-bar curves have not changed, or if the latter have changed any, that they have receded a little. The low-water line opposite the south rocks appears to have receded some 300 feet. At the jetty end, however, it moved out and also along the jetty on the channel side. This movement has continued since the survey of 1886, as shown by the subsequent making of a point inside of the jetty end, which forces the channel to curve towards the north. Between the times of the two surveys, 1885 and 1886, the channel has deepened, just as it now has since the last survey.

Comparing the surveys of 1880 and 1886, which comparison is of more value since the including period is longer and covers the time of jetty construction, it is noticed that the inside 12-foot curve of the bar has moved out about 1,700 feet and the 18-foot curve about 1,400 feet, while the outer 12-foot curve has advanced about 400 feet and the 18 and 24-foot curves about 300 feet. The distance between the adjacent 18-foot curves of the bar and outer reef, by the last survey, is about 1,400 feet; a 16-foot rock shoal is about midway between these curves. In 1880 the face of the bar was straight and parallel with the outer reef and the general shore-line. Since the present jetty was commenced the bar has become convex towards the reef by an advance of the middle part and perhaps by a small recession at the sides of the entrance.

In connection with the survey of 1886 borings were made in the channel-way and on the bar for further determination of the elevation of the hard bottom. The south end of the outer reef and a 16-foot shoal east of the lower part of the reef were carefully developed. The borings and rock soundings of different surveys are shown on a sheet herewith, which is intended to represent the bottom as if the sand were scoured

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away. Since the date of the map six additional borings have been made north of the line of depression of the bottom as drawn upon the sheet. The new borings would not materially change the plotted curves of equal depth.

The tidal discharge was computed from the surveyed areas of the more considerable part of the tidal basin, and by gauge-readings near the head, middle, and at the foot of the basin. The values found, which are some less than the true ones, are 38,650 and 49,490 cubic feet for mean tide and mean spring. These give mean ebb velocities through the gorge at the entrance 2.01 and 2.43 cubic feet per second.

A rough approximate value of the mean discharge computed from an observed velocity, and a value in excess of the true one, is 42,700 cubic feet per second; 40,000 feet may be accepted as the discharge of an average tide, and 50,000 feet of a mean spring tide.

The section at the gorge shows a central low-water depth of 32 feet and mean depth of 8.6 feet, with widths at high and low tide and at depths of 15 feet or more of 1,940, 1,140, and 420 feet respectively.

Details of current measurements at the entrance and off the outer reef are shown on a tracing herewith. Inside the reef the flood draws towards the entrance from all directions, a considerable part passes over the north spit, while the greater volume flows from the south through the channel. Outside of the reef the flood, at depths observed, appears to draw through an opening in the reef and around its southern end. Concerning these outside floods running south it should be noted that the observations were taken during a fresh northwest wind, and therefore the currents may have been influenced thereby.

The ebb follows the channel to a greater degree than the flood; some current probably escapes over the spit, especially at the first of the ebb; no ebb floats, however, traveled across the spit, although purposely started as far to the north as practicable. Inside the northern part of the reef the ebb flows west; south of this the ebb goes to the south. Off the reef the general direction of the ebb is southerly, but so observed under light northerly winds.

Some anomalous paths of floats are explained, since they were observed, as may be noticed from the tables, at the very first of the flood or ebb, and when the current was not decided.

The wind appears somewhat to influence the currents off the reef and bar. The more continuous winds are northerly, and blow during summer; the storm winds are southerly and winter ones. The tides make along the coast from south to north, and the greater sand movement along the shore is in that direction.

One might expect that the bar channel would move towards the north in winter and to the south in summer, as it does, and that for a fixed position of channel one about midway would be the best.

Turning now to the commercial view of the case, I have to report that the importance of Yaquina Bay as a sea-port has increased during the year, and has now reached such a stage as to necessitate that present constructions be made with a view to their forming a part of the works adapted for the best improvement attainable.

The original project contemplates a 1,700-foot extension of the present jetty in a direction curving well towards the north, and in the expectation to afford a channel of 12 feet depth at low water, or 19 feet at mean high tide.

An extension of this project for giving a greater depth was considered in my annual report, as required by Department instructions. I offered a modification of the project, consisting in a less curving north

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of the south jetty, and in the addition of a certain north jetty, 3,000 feet long, and approaching the south jetty to about 1,100 feet, together with a specified order of construction. The works were arranged to give easy inlet to the flood, and located to favor the natural sailing course to and from, around the south end of the reef, and yet to retain the cover afforded by the reef from the heavy westerly swells.

No notice of action on this proposition has been received.

The work of most urgency is the elimination of the south rocks from the problem; this can now be quickest secured by an extension to the present jetty, and the nearer, in direction, the extension is to a normal to the shore-line, the less length will be required for that purpose; also the nearer the direction is to magnetic west, the nearer will the work be projected head on the heavy seas, and therefore be less exposed. The configuration of the hard bottom, as appears from the map showing the rock or gravel bottom, requires that the channel-way from about opposite the present jetty, and be made to take a westerly direction for some 2,000 feet, and then turn to the south. The nearer the channel-line is to the line of depression of the hard bottom the less channel-way. These considerations, the conclusions concerning the currents, and the advantage of founding the jetty on good bottom, point to the line A B C, but curving a little at B, as the best one for extension of the present work.

On the other hand, the controlling element in fixing the channel position is the bar movement, for pushing the bar much nearer the reef might be very detrimental to the improvement. The movement of the bar seawards appears to have stopped, but this is not assured, and the movement may be resumed when a considerable jetty extension is made.

If the bar continues to go seaward as the jetty is built, then a work on the line A B D is desirable. Until the question of bar movement is settled, construction should be limited to the common part, A B, about 600 feet long. Present funds will permit the building of this part, also needed additional ballasting on the old jetty, also more borings and survey work. I recommend the application of present funds therefor, and materials being assembled by contract; that the work be conducted by hired labor, which, in this case, is the most economical and advantageous for the Government.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through the supervising engineer.)

COMMERCIAL STATISTICS.

Yaquina Bay is in the collection district of Yaquina; Yaquina is the port of entry. The nearest light-house is at Cape Foulweather, 4¼ miles north of the entrance. Yaquina Bay forms with the Oregon Pacific Railroad a competitive line from the Willamette Valley to San Francisco. Three steam-ships belong on the route; two of them are now running. A coasting steam-schooner runs to and from the bay.

The following, furnished by Mr. John Priest, collector of customs, are for the year, June 30, 1887:

Coastwise arrivals, 56; cargo tonnage, 9,244; clearances, 56; cargo tonnage, 21,948. New vessels, 3; registered tonnage, 1,368.93.

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Record of bar crossings.

[Compiled from monthly vessel reports, Engineer Office.]

Draught.	July 1 to June 30—				
	1882–'83.	1883–'84.	1884–'85.	1885–'86.	1886–'87.
Not given				5	27
7 feet and less	11	23	27	4	6
7 to 8 feet	13	15	14	4	8
8 to 10 feet	19	7	26	16	8
10 to 12 feet	5	5	23	20	47
More than 12 feet	1	1	5		23
Total	49	51	95	49	119

Shipments for six months ending June 30, 1887.

[Compiled at Engineer Office from commercial reports.]

Articles.	Quantity.	Articles.	Quantity.
Wheat ..... sacks..	164,906	Wool ..... sacks..	153
Oats ..... do....	25,599	Lumber ..... feet..	5,972
Barley ..... do....	1,574	Apples ..... boxes..	1,909
Potatoes ..... do....	12,321	Apples ..... barrels..	277
Flour ..... do....	2,409	Cedar ..... cords..	34
Flour ..... barrels..	904	Salmon ..... barrels..	906
Hides ..... bundles..	444	Tallow ..... cans..	93
Hides ..... number..	33	Woolen goods ..... cases..	9
Eggs ..... cases..	274	Bones ..... packages..	22
Dried fruits ..... boxes..	187	Scrap iron ..... bundles..	18
Leather ..... rolls..	54	Fowls ..... coops..	6
Oysters ..... sacks..	277	Cattle ..... number..	10
Furs ..... bundles..	23	Miscellaneous ..... packages..	42
Skins ..... do....	155		

Cargo of 1 steam-ship not reported. Cargoes of 8 schooners not reported.

T T 5.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON TERRITORY.

The project of this improvement is to build a low-tide jetty, about 4½ miles long, from near Fort Stevens, on the South Cape, by a slightly convex curve on the north, to a point about 3 miles south of Cape Disappointment; some latitude in the length of the jetty is permitted; also for an increase of contraction, by raising it or by building a short work on Peacock Spit. A certain construction of stone and beton blocks resting on a foundation course is required, on an estimate of cost, without contingencies, of $3,710,000. Stone is to form the great mass of the structure, but the use of wood as mattresses or piling is recommended wherever practicable or economical. A channel depth of 30 feet at low water is intended.

The amount appropriated since the adoption of the project is $287,500; the amount expended thereon is $126,860.64.

Under the first appropriation, that of 1884, a plant had been assembled, and the jetty begun by building from land by means of an elevated tramway.

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During last fall and winter, and under the appropriation of 1886, the principal operation conducted was a search for a stone supply, from the place of which a small railroad could be run direct to the jetty. No stone quarries, whatever, had been opened in the adjacent region. Our reconnaissances, made previously, had discovered sandstone outcroppings of a doubtful quality in some spurs of the Clatsop Ridge, within 9 miles of the jetty. Good basalt had been found at the most westerly projection of Tillamook Head, some 20 miles distant; but the estimated cost of a single narrow-gauge track to this place was about $175,000; and it was judged that the maintenance of part of the line would be very difficult. Effort was therefore directed to developing the nearer place, known as Carnahan's, in the hope that the sub-surface stone would be suitable for foundation course or filling, especially as the location was on the way to Tillamook Head. Quarry faces were opened at three points, and at the most favorably appearing one a small tunnel was run into the bluff for 50 feet, or 80 feet from the original surface. The quality of the stone did not improve, and it was found that the waste would be considerable. In the mean time search had been extended south, along the western side of the ridge for about 6 miles, where a force afterwards opened several quarry faces. No suitable stone, however, was obtained. Examinations were then extended further south and up the Nekanakum Creek, east of Tillamook Head, where hard basalt was found, but in layers so thin that large pieces of stone could not be obtained. Explorations were also conducted along the crossing of the ridge to the Lewis and Clarke River, thence south through the cañon of that river and up tributaries and gullies, with results of finding only poor rock; but north from the crossing and about 12 miles from Fort Stevens, where some branches descend from the foot-hills on the east side to the unnavigable main stream, sandstone of a fair quality was obtained. This locality, now known as the Christmas district, was fully developed. It contains also good basalt, but in limited quantity. The sandstone is in large quantity, with high face, requires no considerable stripping, and holds its quality below the surface.

Reconnaissance for a rail line was made down the Lewis and Clarke, and thence along the Columbia River shore to Fort Stevens, and a preliminary survey run across the divide to the plains near Carnahan's. The cost of the latter line, not equipped, would be about $125,000, and more for the former.

On the whole the results of the examination for a land delivery of stone were not satisfactory, especially in view of the limited appropriation and the urgency for building about one-third of the jetty to close Tillamook Chute. It appeared as though recourse must be had to a delivery by barge and transfer of stone over a wharf to the jetty, the method followed during the first season of work. The wharf had wholly shoaled, so that its use rendered necessary a considerable extension, which, most likely, would also shoal after another year. There being no good wharf location on the reservation, a site was selected nearly 2 miles up-stream and on private land, where the shore was free from the large movements of sand, and where also the seas and tides would permit work during a longer period of the year than at the Stevens Wharf.

In expectation that the needed authority for the purchase of land would be granted by Congress, plans and specifications for the new wharf were made, and a rail line from it to the present shore tramway located and estimated upon.

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As the prohibition against the purchase of land remained, the contract specifications for furnishing stone were drawn to permit the stone to be delivered as the bidder might specify, either on barges at the Fort Stevens Wharf or upon cars at any point upon the reservation. The results of the quarry examinations and rail surveys were explained to bidders. Bids received for the land delivery were large and the stone offered was of the poor kind from Carnahan's. A bid for a barge delivery was accepted and the Stevens Wharf extended. Up to the end of the year no stone had been delivered. The contract time of commencement of delivery has expired. However, the contractors are preparing in good faith to execute their large contract, and it is less advantageous to the Government to annul the contract than to wait a short time. In the mean time piles are being received and driven in the tramway or stored for convenient use for jetty extension, more dump cars being set up, and other preparations made to handle the maximum daily quantity of stone which can be required under the contract.

During the winter the jetty was extended shorewards 400 feet, on account of a movement in that direction of the high-water line, so that the seas, in racing along the jetty and swinging around its end, undermined some of the piles of the shore tramway and threatened more damage. The jetty and the jetty tramway have remained in good condition. The stone along the north or exposed side has settled, while the sands have banked against the other side. To partly compensate for the settlement, some stone was moved from the protected to the exposed side. One hundred barrels of cement stone were removed from a vessel-wreck on the beach and placed in the jetty as an experiment to see about so using a large number of the barrels; but it was found not to be worth while from the expense, and since the seas moved the blocks about where they were not wedged between the ordinary stone of the jetty.

A survey was made in September of the bar channel, and of Clatsop Spit, across which the jetty is to be built. The bar channel during the preceding year continued to lengthen by moving somewhat to the south and east, and will probably, if not prevented, repeat its history when the course of the out flow shall have become too long, by breaking out to the north across the outer sands, thus giving two or three channels with good water in neither. The opening across Clatsop Spit, known as Tillamook Chute, did not deepen from 1885 to 1886; the river end, however, widened and moved outwards a little towards the end of the spit. The width of the opening on the jetty line, between 12 feet low-water curves, by the 1886 survey, was 4,000 feet; the central depth was about 20 feet, and the chute about 1¾ miles ahead of the jetty. It is very desirable, as explained in the previous report, to close this outlet by building the jetty over it, or at least by laying a foundation course in advance and promptly connecting the jetty with it. The extent of this urgent work can be judged from the measurements given and a consideration of the exposure of the locality.

The estimate for next year is for the extension of the jetty over the opening. There is every reason in this case for rapid construction.

Lieut. Edward Burr has assisted on this improvement and other improvements, and Assistant Engineer P. G. Eastwick has remained at the work superintending the quarry operations, land surveys, and jetty construction.

The improvement is important and of magnitude. Present, as well as

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prospective, commerce requires a deepening and stability of the entrance channel.

Two trans-continental railroads now terminate on the Willamette and Columbia rivers, and a third road will probably do so in a few months. The mouth of the river is the natural sea outlet for the Lower Columbia region, the Willamette Valley, and the great Upper Columbia country, comprising parts of Oregon, Washington, Idaho, Montana, and British Columbia. Accepted estimates of the eastern Oregon wheat yield for export, now that the harvest has begun, is about 400,000 tons, a very marked increase over any preceding year. Details of the wheat, flour, and salmon fleet for a year are given in the last report. Foreign lumber shipments generally and lumber and flour shipments to China are increasing. The sailing times of the San Francisco steam-ships have been increased, and a steamer has commenced to run from the Columbia River for connecting with the Canadian Pacific road and its steamers to China and Japan.

Attention is invited to the tabulated statistics appended.

APPROPRIATIONS.

Act June 18, 1878	$5,000.00
Act March 3, 1879	5,000.00
Act August 2, 1882	7,500.00
Act July 5, 1884, for commencing jetty on plan of majority of Board of Engineers of 1882	100,000.00
Act August 5, 1886	187,500.00
Total	305,000.00

Money statement.

July 1, 1886, amount available		$1,433.61
Amount appropriated by act approved August 5, 1886		187,500.00
		188,933.61
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$28,868.55	
July 1, 1887, outstanding liabilities	6,105.75	
		34,974.30
July 1, 1887, amount available		153,959.31
Amount (estimated) required for completion of existing project		3,422,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		1,200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for furnishing and delivering 1,200 *fir piles,* 50 *to* 55 *feet long.*

No.	Names and addresses of bidders.	Rate per linear foot.	Amount.	Remarks.
		Cents.		
1	L. Michael, Portland, Oregon	8	$5,040	Informal, only one copy of bid received.
2	Oregon Paving and Contract Company, Portland, Oregon.	8	5,040	Accepted.
3	Nelson Hoyt, Warren, Oregon	9	5,670	

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Abstract of proposals for furnishing and delivering 50,000 tons of stone.

No.	Names and addresses of bidders.	Delivery.	Price per 2,000 pounds.	Quarry.	Samples of stone.
1	Hoffman & Bates, Portland, Oregon.	Barge	$0.73	.....	Basalt.
2	Vincent Cook, Portland, Oregon.	....do	.79	Bugbee	Do.
3	David, Smith & Pacquet, Portland, Oregon.	....do	.74	.....	
4	.....do.....	Car	1.05	Carnahan (sandstone)	
5	Oregon Paving and Contract Company, Portland, Oregon.	....do	.95	.....do	
6	.....do.*	Barge.....	.63½	Bugbee, Cathlamet, Oak Point, Skamokawa, Tongue Point, and Astoria; all basalt.	Basalt from Cathlamet and Tongue Point.
7	.....do.....	....do	.56	Hungry Harbor, Point Ellis, or mouth John Day's River; all sandstone.	Sandstone from mouth John Day's River.
8	L. Michael, Portland, Oregon.†	....do	.60	Bugbee	Basalt.
9	..... do.†	....do	.62	Within 5 miles of Astoria.	Sandstone.
10	Patrick O'Neil, Portland, Oregon.	....do	.68	Custom-house quarry, opposite Astoria, Oregon.	Do.

* Accepted. † No guaranty; otherwise informal.

Abstract of contracts.

No.	Names and addresses of contractors.	Date of contract.	Subject of contract.
1	Oregon Paving and Contract Company, Portland, Oregon.	June 2, 1887	Furnishing and delivering on barges at Fort Stevens, Oregon, 50,000 tons stone.
2	.....do	June 2, 1887	Furnishing and delivering on beach at Fort Stevens, Oregon, 1,200 fir piles.

COMMERCIAL STATISTICS.

The following table refers to the collection districts of Willamette and Oregon. The sea commerce of both districts passes the mouth of the Columbia. The other tables show the principal fleets and principal exports for which the mouth of the Columbia affords a competing line. Besides those fleets are the steamship line to San Francisco, a line to Alaska, a line to British Columbia, a packet line to China, colliers to Puget Sound, and local coasting vessels. Vessels seeking charters bring coal, teas, salmon-canning material, and general merchandise, or come in ballast.

Customs Statistics.

[Compiled at Engineer office from collector's reports.]

Period.	Amount of revenue collected.	Value of foreign—		Coastwise.*			Foreign.		
		Imports.	Exports.	Entrances.	Clearances.	Registered tonnage.	Entrances.	Clearances.	Registered tonnage.
				No.	*No.*	*Tons.*	*No.*	*No.*	*Tons.*
1875–'76 (11 months)	$28,011.00	$355,462.75	$3,866,507.80	304	251	546,409	53	143	163,387
1876–'77 (11 months)	151,695.10	412,791.00	3,998,088.00	262	214	537,906	51	133	137,239
1877–'78 (11 months)	147,352.35	464,521.51	6,063,613.65	406	344	886,495	56	151	193,294
1878–'79 (11 months)	160,220.71	400,005.00	5,110,608.00	350	314	1,169,758	85	156	225,309
1879–'80 (11 months)	126,507.82	292,909.70	6,054,409.40	316	280	969,174	91	159	225,260
1880–'81 (11 months)	446,845.01	695,136.00	3,886,033.00	321	263	1,103,142	82	108	159,061
1881–'82 (12 months)	395,369.25	779,189.00	10,418,136.00	406	339	1,408,956	164	299	434,135
1882–'83 (12 months)	439,972.07	719,812.00	6,835,347.00	506	423	1,464,597	85	163	275,683
1883–'84 (13 months)	472,628.63	979,140.00	7,794,060.00	463	401	1,166,595	85	169	151,308
1884–'85 (12 months)	243,974.03	446,318.31	6,139,465.52	379	301	902,025	114	179	286,421
1885–'86 (12 months)	264,298.69	553,567.00	7,055,083.33	404	310	972,979	129	204	365,489
1886–'87 (12 months)	288,924.39	1,050,915.00	6,492,306.00	375	329	975,859	105	175	302,213

*Does not include California lumber fleet, Puget Sound colliers, nor local coasters; which vessels do not report at custom-house.

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Columbia River canned-salmon shipments, July 1 to June 30.

[Compiled at Engineer office from commercial papers.]

Year.	East, by sea.	East, by rail.	San Francisco, by sea.	Foreign, by sea.	Puget Sound by sea.	Total.	Value.
	Cases.	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	
1883–'84	.....	.....	.....	.....	.....	652, 388	$3, 261, 940.00
1884–'85	.....	321, 600	115, 811	184, 596	.....	622, 007	2, 861, 232. 20
1885–'86	37, 541	240, 255	102, 610	213, 947	300	594, 653	2, 568, 900. 96
1886–'87	.....	315, 969	89, 563	162, 607	.....	568, 139	2, 840, 695. 00

Columbia River lumber fleets.

[Compiled at Engineer office from Mills' statement.]

Year.	Number of vessels to ports.		Thousand feet.	Value.
	Foreign.	Domestic.		
1883–'84 (fiscal)	1	52	21, 788	$220. 654. 00
1884–'85 (fiscal)	6	69	29, 251	*306, 075. 00
1885–'86 (fiscal)	12	65	26, 547	†279, 838. 00
1886 (calendar)	6	65	29, 274	‡321, 081. 36

*Inclusive of value of 100,000 lath, 74,000 feet piling, 111 cords wood 7,000 shingles, and 41,000 feet lumber to San Francisco per regular steamship.

†Inclusive of value of 5,364,825 lath and 302 piles.

‡Inclusive of value of 1,535,925 lath, 200 piles, and 407 telegraph-poles.

Columbia River wheat and flour fleets, July 1, to June 30, foreign bound.

[Compiled at Engineer office from commercial papers.]

Year.	Vessels.	Cargo.	Value of cargo.
	Number.	*Tons.*	
1877–'78	74	72, 907	.....
1878–'79	67	67, 200	.....
1879–'80	82	72, 975	.....
1880–'81	61	61, 980	.....
1881–'82	164	222, 529	$7, 648, 684
1882–'83	79	135, 622	5, 033, 464
1883–'84	88	132, 510	4, 658, 204
1884–'85	110	166, 186	4, 380, 355
1885–'86	131	224, 980	6, 019, 678
1886–'87	116	201, 015	5, 568, 130

Wheat and flour shipments.

[Compiled from Portland Oregonian.]

	Centals.	Value.	Barrels.	Value.
Europe	4, 277, 447	$5, 531, 869	461, 674	$1, 688, 697
San Francisco	392, 905	460, 242	52, 751	193, 121
Coastwise and northern	48, 994	56, 810	89, 269	318, 757
Hong-Kong	.....	.....	2, 000	9, 000
1886	4, 719, 346	6, 048, 921	605, 694	2, 209, 575
1885	4, 546, 542	5, 643, 655	459, 159	1, 751, 589
1884	2, 627, 640	3, 313, 325	508, 467	2, 201, 094
1883	2, 372, 960	3, 672, 637	423, 686	2, 082, 945

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Value of domestic exports, consisting of wool, oats, barley, mill-stuff, potatoes, onions, woolens, hides, tallow, hops, ores, etc., and exclusive of wheat, flour, lumber, and salmon.

Year.	California ports by sea.	Coastwise and northern by sea and rail.	Eastward by rail.	Total.
1886	$2,481,154	$268,117	$2,665,915	$5,415 186

Principal exports to San Francisco, exclusive of those by lumber fleet, January 1 to June 30, 1887.

[Compiled at Engineer Office from commercial reports.]

Articles.	Total.	Articles.	Total.
Wheat.....centals..	439,321	Ores .....sacks..	4,286
Flour.....barrels..	44,863	Staves.....bundles..	3,116
Barley.....centals..	3,267	Bones.....sacks..	1,549
Oats.....do....	78,371	Dried fruit.....boxes..	1,836
Potatoes .....sacks..	61,929	Apples .....barrels..	263
Onions .....crates..	2,213	Do.....boxes..	13,906
Do.....sacks..	5,425	Flax-seed .....sacks..	2,995
Wool.....pounds..	943,575	Oysters .....do....	305
Salmon.....cases..	2,517	Stoves .....number..	646
Do .....barrels..	34	Wood-pulp .....bundles..	2,132
Lumber (hard) .....feet..	478,190	Leather.....rolls..	50
Live stock.....number..	24	Woolen goods.....cases..	285
Hides and skins.....do....	24,646	Glue stock .....pounds..	47,153
Do.....bundles..	1,554	Oil .....casks..	1,111
Do .....pounds..	140,801	Tallow .....cans..	428
Hoop-poles .....bundles..	5,824	Paper ..... bundles..	466
Mill-stuff .....sacks..	17,033	Scrap iron.....tons..	390
Laths.....bundles..	120,588	Miscellaneous.....packages..	3,111

T T 6.

CONSTRUCTION OF CANAL AT THE CASCADES OF THE COLUMBIA RIVER, OREGON, AND WASHINGTON TERRITORY.

The plan is to build a canal and lock at the Upper Cascades and make an open river improvement at the minor rapids below, for navigation, to a 20-foot rise at the foot of the canal, with, perhaps, some assistance to ascending vessels at the minor rapids. The 20-foot rise includes the medium river stage and obtains from seven to eight months of the year. The plan is arranged for extension of navigation to higher stages. The lock is to be 462 by 90 feet, and have, at low water, a 24-foot lift and 8 feet depth on the sills. There is to be a guard-gate near the head of the canal and guard-gates at the head and foot of the lock.

The amount appropriated is $1,142,500, and the amount expended $1,058,853.36.

Operations had been generally suspended, from want of funds, for several months previous to August, 1886. Under the appropriation of that year preparations were made to resume work, and some work was conducted and then stopped for a short time.

The improvement was transferred to me October 9, 1886. Operations were resumed on Monday, October 11, and continued through the year with a full force, excepting in February, when a curtailing was judicious from severe winter weather, and again in April, May, and June, from a flooding of the canal by backwater of the Columbia rise over the bulkhead at the lower entrance.

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The principal operations were excavation, about 58,000 cubic yards, and mainly in conglomerate at the low levels of the lock-site; stone-cutting, 41,487 square feet; bowlder quarrying, 1,002 cubic yards, and paving slope of canal at the upper entrance, 1,193 cubic yards. A small wharf was built next above the head of the canal and a permanent tramway of 25-pound iron laid therefrom on the left, conveniently to the construction buildings, and nearly to the lower end of the canal. Some betterments were made to the construction buildings. Excavated material was used in grading grounds and tramway bed, or reserved for future use. The details of these and other operations are given in the appended report of Capt. W. Young, resident engineer.

The Cascades plan required that lock construction should await the river improvement, in order to furnish certain necessary data concerning that construction, and that the river work should be carried to a certain point for determining the extent and cost of further work; also, in case the river improvement should not be satisfactory for navigation to the 20-foot stage, that it should be supplemented by a lock and dam at Bradford's Island, and in the mean time that canal excavation should be continued and lock material accumulated.

The river work being, therefore, the controlling element in the improvement plan, it has been conducted when funds and the river condition permitted and the canal work made secondary thereto. The former work has now been completed, it is believed, to the points required by the plan; it was stopped in March, 1885. The project for applying the next appropriation, 1886, concerned canal work only.

A radical change has been effected in the regimen of the river. The general result is a considerable improvement and a promise that the work can be made satisfactory for navigation to the 20-foot stage at an admissible cost, and that the river is susceptible of improvement for higher stages. There has been no regular navigation on this part of the river to give a continued actual test.

Daily gauge-readings have been made and river phenomena carefully observed for eight years, before, during, and after the times of the river and canal works. Previously nothing was reliably known of river matters pertinent to the detailed plans of construction; as, for example, a low water at the foot of the canal was actually observed on an open river last winter, 4.1 feet lower than what was, at the commencement of the improvement, believed to be dead low water; a correspondingly lower water at the head of the canal was found during a freeze-up in 1884. Decided differences at higher stages have also been noted. These differences at both high and low waters are referable to the want of correct information and to changes of the river regimen caused by the improvements works. Last winter the eight years' observations were tabulated and plotted, and fully studied by me, and deductions made upon which to base detailed plans of construction.

The estimates of cost for completing the canal with the single lock, carefully revised during the the year and based on the costs of work done, give a total in round numbers of $1,850,000. The increase over the original estimate results principally from previously uncounted expenses from suspension of work; the severity of the climate and difficulties of the situation at the Cascade gorge, were, I judge, not sufficiently considered. The summer rise of backwater at the lock-site was, in 1880, 54.5 feet; in 1882, 52.2 feet, and in 1887, 49.3 feet. The rain-fall last December was 20.9 inches; in January, 29.9 inches, and for the year, about the average, 8.5 feet, while severe cold weather, with very sharp winds, occurred through the winter and especially in Feb-

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ruary; it is plain that such weather seriously interferes with work. The following extract, which puts the matter justly, is from the report of Capt. P. M. Price, when resident engineer in 1883:

In this connection it may be well to state some of the unusual difficulties attending the prosecution of this work with a view to showing the great saving to the Government in the ultimate cost of the canal which would result from the granting of much larger appropriations than have heretofore been made.

The annual flood of the Columbia River comes with absolute certainty, attaining its maximum between the 10th of June and 10th of July. The greatest rise above extreme low water at the foot of the canal is 55 feet, and the average rise is about 45 feet. To exclude the flood waters entirely from the canal would require the building of a coffer-dam half a mile in length and varying in height from 40 to 75 feet, according to the depth of the bed-rock, at so great a cost that the idea has not been entertained. An embankment across the canal near its head, the protection-wall and embankment on the right and a tight crib-work across the canal near its foot, have however been so arranged as to permit the pumping out of the canal up to a stage of 20 feet above extreme low water. No work, either of laying masonry or excavating, can be done in the canal from about the middle of May to the middle of August, which comprises the driest and most favorable period of the year for working. During most of the remainder of the year, when the water is low and work in the canal must be carried on, the rain-fall is excessive, and frequent snow-storms occur during the three winter months.

* * * * * * *

During the greater part of the busiest working season, therefore, the men have to work in oil-skin coats and rubber boots, and our experience is that only about half work can be got out of them when so incumbered. This fact alone will undoubtedly increase the cost of the canal above the original estimates.

The water and mud preclude the use to any extent of wagons, carts, and sleds, and transportation is effected on tramways, with cars drawn by mules.

The canal site and the ground on either side of it was originally exceedingly rough and broken, covered with a mass of bowlders, varying from one-half to one hundred tons and more in weight, and most of the excavation for the canal is in gravels filled with such bowlders, the remainder being in a rather soft bed-rock. All the stone so far used in the walls has been obtained from quarrying or blasting these basaltic bowlders. To handle the stone and excavated material, derricks and hoisting-engines are used.

The great rise of water during floods causes a very large annual expense for the moving and protection of this heavy plant and other property. It must be all either moved or effectually protected at the beginning of the flood, and must be again moved into position and put in readiness for work on the subsidence of the water. The annual protection and moving of property and heavy plant consumes a large percentage of the small appropriations hitherto made, and counts nothing towards the completion of the canal.

It can therefore be readily understood that to carry on the work economically, and complete it for a sum near the estimates, such appropriations should be made annually as will complete it within the *least number of years*. In order to accomplish *anything* a certain amount of plant, machinery, etc., is necessary, and the money available should be such as to permit this machinery to be worked to its full capacity during the low-water season. The only work that can be done during the summer is stone-cutting, the paving of the left bank above high water, the clearing and grading of the high ground on the land side of the canal in order to make working grounds for stone-cutting and shops, and for storage of stone and other materials, and the repair and manufacture of plant.

* * * * * * *

The appropriation recommended for next year, $400,000, is for canal work. In the following year a larger amount can be judiciously used. Nothing is included for further river improvement, although I believe at least $100,000 should be available for that work, so that the funds can be applied when a very low stage of fall and early winter with good weather may come. Such favorable conditions occur at irregular and sometimes long intervals, and much saving can be effected when they obtain by doing river work, and more convenience to navigation at an earlier time thereby secured.

A free wagon-road portage, about 3,500 feet long, through the canal grounds, was opened by direction of the Secretary of War a year and

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a half ago. Subsequently a steamer went to the Cascades to be hauled around the main rapid for competitive service between The Dalles and the Cascades, but was burned near the rapid. A steamer is now being built above the Cascades, and, it is understood, for similar competitive service. No use has yet been made of the wagon portage.

The railroad company owning the single line along the Columbia River also own all the steam-boats above the Cascades and a rail portage on the Washington side at the Cascades, so that there is no competition whatever from the upper Columbia country to ship navigation. A table appended shows the rates on grain, which are about the least of the freight tariff. It can be noticed that it costs very nearly half as much to carry grain for some 240 miles along the Columbia River to the head of ship navigation as it does from that point to Europe.

The Columbia River below The Dalles has a natural low-water depth, except at the Cascades, greater than that projected by the Mississippi River Commission from the mouth of the Illinois to Saint Louis, and equal to that projected from Saint Louis to Cairo. Above The Dalles the Columbia River has a navigable depth equal to that of the Ohio.

A free river highway is prevented by the serious obstructions at the Cascades and Dalles.

On account of small and uncertain appropriations the opening of the Cascades Canal will require several years. For the same reasons so will an adequate improvement at The Dalles, and which is not yet authorized. The estimate for the open river and canal works at The Dalles, submitted from a survey for compliance with the act of March 3, 1879, to give navigation for the same part of the year as the Cascades Canal, is a little less than $7,700,000. An estimate for a single steam-boat railway in two sections, with navigation at an intermediate rapid, has been placed at $1,373,000.

Prompt and temporary relief can be afforded by public portage railroads; they can be built in six months and at moderate cost. In the meantime the canal work at the Cascades and an improvement at The Dalles can be completed. The least length of portage at The Dalles would be 10 miles, and at the Cascades 4,000 feet. The former would cost, double-track narrow gauge, equipped and ready for use, less than $250,000 and not over one-fifth that amount at the Cascades.

Below the suggested Dalles portage is a rapid, where steam-boating at low and medium stages is practicable but not convenient. The estimate for full improvement at the rapid is $252,300. Each year's work there will furnish some benefit. Improvement at this rapid will be required in any plan of permanent improvement at The Dalles. Or the portage road could be extended 3 miles to a good place for a landing below at about $300,000 total cost for the longer portage.

The report of the Board of Engineers on the Cascades Canal, 1880, suggested a rail portage for temporary use, but refrained from its positive recommendation, since the Government land was limited to a narrow strip, and the establishment of a thoroughfare might interfere with the construction of the canal. Additional land has since been acquired, so that the portage interference would now be less. Both tracts were obtained by condemnation, and the first tract, across which the portage would necessarily run, for building a canal. If there are legal objections to making the portage on the canal land it could be located on the Washington side, where there is a better landing at the lower end, where the least length of road would be one mile, and at a cost for land, single track-equipped, and landings, of about $100,000. Regulations for operating the portage and rates for transportation

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should be made, and the use of the portages let to the highest bidder on bonds for faithful service. The distance between the portages would be about 50 miles, and transportation people using them or the operating contractor would, when the traffic became at all considerable, provide ships and pontons and transfer freight in cars on boats from portage to portage. The portage system outlined would reduce and control rates and be the first step giving results of immediate benefit towards opening the Columbia River from the boundary to the sea.

If it be deemed not expedient to grant funds for both portages, then it is recommended, in the interest of commerce, that appropriation be made for the Cascade portage, $50,000 or $100,000, as the portage may be located on the canal land or not.

APPROPRIATIONS.

Act June 14, 1876, canal around cascades of Columbia River, Oregon	$90,000
Act June 18, 1878	150,000
Act March 3, 1879	100,000
Act June 14, 1880	100,000
Act March 3, 1881	100,000
Act August 2, 1882	265,000
Act July 5, 1884, improving Columbia River at Cascades, Oregon	150,000
Act August 5, 1886	187.500
Total	1,142,500

Money statement.

July 1, 1886, amount available		$2,772.93
Amount appropriated by act approved August 5, 1886		187,500.00
		190,272.93
July 1, 1887, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1886	$106,626.29	
July 1, 1887, outstanding liabilities	3,819.26	
		110,445.55
July 1, 1887, amount available		79,827.38
Amount (estimated) required for completion of existing project		1,850,000.00
Amount that can be profitably expended in fiscal year ending June 30, '89		400,000,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Abstract of proposals for constructing a wharf.

No.	Name and address of bidder.	Amount.
1	Pacific Bridge Company, by C. F. Swigert, agent, Portland, Oregon	$2,500
2	Portland Construction Company, by J. G. Warner, president, Portland, Oregon *	2,290
3	J. J. Holland, Portland, Oregon	2,998

* The justification of guaranty is omitted from both copies of proposals, but the guarantors are both well known as business men in good standing. Each one is believed to be worth more than the amount of guaranty.

Abstract of contracts.

No.	Name and address of contractors.	Date of contract.	Subject of contract.	Expiration of contract.
1	Portland Construction Company, Portland, Oregon.	Nov. 9, 1886	Constructing wharf at Cascades Canal.	Dec. 8, 1886

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REPORT OF CAPTAIN W. YOUNG, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cascade Locks, Oregon, June 30, 1887.

SIR:

* * * * * * *

No open river work has been attempted during the year.

The principal canal work has been in excavating, in grading grounds and roads, in cutting stone, and in paving the right bank of the canal at the upper entrance.

Most of the excavation for the year has been in what is locally termed "bed-rock," which is a formation resulting from the hardening—mostly from chemical action—of a lacristrine deposit of volcanic ash and mud, mixed, more or less, with water-worn pebbles and rock fragments. This bed-rock, where not exposed to the action of the air, is of considerable though of varying hardness.

In some cases it is almost as hard as flint, but usually it is what may be, for a rock, termed soft. When broken into fragments and exposed to the air most of it disintegrates and falls to pieces in much the same manner that lime does on air-slaking.

The method adopted for excavating this rock was to break it up by drilling and blasting, and then to load it into car-boxes, which were hoisted by derricks and put onto dump-cars ready to be hauled away by mules. The drilling was done by 3¼-inch Ingersoll steam-drills, with special bits of ✠ this cross-section, and, where necessary, by hand-drillers.

Owing to the fact that the supply of blasting powder in the Portland market was usually very limited, we were forced to use various grades and kinds of powder during the season. Some low-grade powders, put up in special water-tight wrappings, were obtained from California, for experiment in blasting in wet holes. We had no success, however, with these where water was present, so that resort was had, in these cases, to the higher-grade dynamites. The special low powders, as well as the ordinary black blasting powders, succeeded very well in dry holes. A serious fault, however, was found with all the low powders, in that they did not break the "bed-rock" into fragments small enough to be lifted by hand, so that, where they were used alone, the workmen had to resort to block-holding and blasting, or to splitting with wedge or pick, to enable them to load the rock into boxes. Where, on the contrary, a sufficient quantity of high-grade dynamite was used with the low powder, the rock was broken into small pieces, ready to be loaded at once. Though the high-grade powders cost considerably more than the low, we found it economical to use enough of the high grade to properly break the rock for loading.

Of course care was taken, and must be taken in the future, not to use the strong powders near the foundations, where they are liable to crack and split the rock on which the masonry is to be laid.

Wherever it was practicable to do so the charges were fired in groups and by electricity, as much better results were thus obtained than by firing the charges singly or by time-fuze. Care and judgment were necessary in locating the holes and in loading them. Many experiments were made to determine the best manner of loading. Generally the best results were obtained where the following method was adopted:

The holes were each sprung several times, to get as large cavities as practicable at the bottom. These were filled completely full with a mixture of No. 1 (70 per cent.) and No. 2 (40, 30, or 20 per cent.) dynamite, in about the proportion of 1 to 9. The grade of the No. 2 was determined by the character of the rock to be blasted. The holes above the cavities were loaded to within 3 feet of the top with No. 1 dynamite. The exploders were then put in and the holes entirely filled up with dry sand. Short cartridges, 4 inches in length and in diameter about a quarter of an inch less than the holes, are to be recommended, as they are not so liable to be broken in the loading as longer or larger ones, and so better protect the powder from water should it be present.

EXCAVATION.

The following tabulated statement will give all necessary data respecting the work of excavation.

It was found impracticable to keep separate accounts for the different kinds of material excavated further than is here indicated.

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Excavation notes.

Material excavated.	Quantity.	Price per cubic yard.	Total cost.
	Cubic yds.		
Bed-rock from canal prism, stations 16 to 24	35,713	$0.9084	$35,894.18
Silt from canal prism, stations 16 to 24	3,801		
Silt and gravel from upper entrance to canal	11,862	.3928	4,659.52
Gravel from lower entrance to canal	804	.0845	67.98
Rock removed and piled, lower entrance to canal	1,811	1.936	3,507.11
Earth and gravel for caisson gate, station 12	1,146	.4562	522.78
Earth and gravel for wing-wall on left, station 17+75	2,492	.512	1,275.56
Earth and gravel between stations 7 and 12	406	.5625	228.49
Total	58,035		46,155.53

Amount of bed-rock excavated, requiring drilling, blasting, etc., 35,713 cubic yards, which required 22,234 pounds high-grade dynamite, 20 to 72 per cent.; 1,235 pounds low-grade dynamite, 4 to 10 per cent.; 6,200 pounds black powder. Total amount, = 29,669 pounds, or $\frac{5}{6}$ pound per cubic yard excavated.

The total cost of explosives, fuze, caps, exploders, etc., was $5,456.29. The total cost of labor in blasting, care of magazine, etc., was $669.27. Total material and labor, $6,125.56.

Cost to blast per cubic yard, 17.15 cents.

Steam drilling.—Number of feet drilled, 8,453½; number of holes drilled, 548; average depth of holes, 15.42. Cost of drilling: Labor, $1,429.28; material, $383.28; total, $1,812.56. Cost per foot drilled, 21.32 cents. Average depth drilled per hour, 4.82 feet.

Gang drilling.—Three men. Number of feet drilled, 9,526; number of holes drilled, 1,381; average depth of holes, 6.9; average depth drilled per hour, 1.8. Cost per foot (approximate), 36 cents.

Location.	Number boxes raised.	Containing, cubic yards.	Cost per cubic yard.	Total cost.
Canal prism	55,350	39,514	$0.908+	$35,894.18
Upper entrance	11,785	11,862	.39 +	4,659.52
Lower entrance	4,758	2,615	*1.367+	3,575.09
Caisson recess	1,281	1,146	.456+	522.78
Wing-wall, left	3,690	2,492	.512	1,275.56
Between stations 7 and 9	404	406	.563	228.49
Total	77,268	58,035		46,155.53

* Most of this was clearing away and piling stone.

GRADING GROUNDS.

All the material excavated from the site of the lower lock was dumped on the river side of the canal, with a view to grading up to above high water the ground lying next to the canal and just below the powder-house island, so that it can be used for working and storage grounds. Tramways, built on trestle-work, and leading from the several derricks, were laid with a slight down grade, so that one horse could pull two loaded cars out to the end of the dump and bring the two empty cars back. The trestle-work was built of young fir-tree buts, cut from the woods in the immediate vicinity, and so was not expensive. The dump was kept graded up to the level of the track as it progressed, so as to form a firm footing for the animals hauling the cars.

The material taken from the upper entrance near station 4 was used in grading a road-bed for a tramway running to the new wharf, and in building a dam across the depression between the canal bank and the powder-house island. A great many bowlders were met with in this work, and these were quarried and piled under the derricks doing the excavation. Some very fine stone for lock purposes was thus obtained.

The material taken from the site of the high wing-wall and from the site of the caisson recess was used in grading grounds around the mess-house and stable.

The material taken from the canal between stations 7 and 12 was used in grading on the right slope preparatory to paving.

Total quantity of material moved, 56,224 cubic yards.

Cost of grading per cubic yard moved, $0.218.

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TRAMWAYS.

A permanent tramway of 25-pound T-iron has been laid from the derrick on the new wharf at the head of the canal to the derrick on the paved slope below the pump-house at the foot of the canal. This will be used in transporting stone, sand, lumber, and wood from the wharf to the proper working or storage grounds, and could be used as a portage railway by the general public for carrying wheat and like freight should it be needed for that purpose.

The length of this tramway, including two turn-outs, is 3,880 feet.

Cost of above, not including rails, fish-plates, and bolts, nor grading, $8,751.53.

Besides the above the following tramways were laid for grading purposes:

	Feet.
New tramway of heavy T-iron, about	1,325
New tramway of light T-iron, about	4,219
New tramway of strap iron, about	2,500
Old tramway relaid of light T-iron, about	1,421
Old tramway relaid of strap iron, about	2,000

The cost of the above is included in the cost of grading grounds.

BUILDINGS.

A new building, 30 feet by 90 feet, has been erected near the old stone shed. One end is occupied as a blacksmith-shop and the other as a machine-shop, which is fitted up with a New Haven screw-cutting lathe of 8-feet bed; a Putnam drill No. 2; a Merriman bolt-cutter No. 2; a 36-inch grindstone, and a No. 1 Sturtevant blower. The blower furnishes the blast for five forges in the blacksmith-shop. All the machinery is run by an old vertical hoisting-engine, purchased from the contractors, Ball & Platt, and which was hardly worth repairing for hoisting purposes.

A competent machinist has been employed most of the year in repairing hoisting-engines, pumps, steam-drills, and in work on car and derrick irons.

Some changes have been made in the old "stone-shed" building. The overhead traveler has been taken down, and a carpenter-shop has been fitted up in the upper part of the north side of the building. The riggers' store-room and loft have been enlarged. The south side of the building is to be used as a timber-shed, and the north side, under the carpenter-shop, as a store-room for hoisting-engines and other machinery.

Some slight repairs have been made, as needed, to the various buildings used as quarters, store-houses, and mess-room.

Cost of constructing machine and blacksmith shops, including pulleys and shafting, $1,242.76.

Cost of machinery in machine-shop, including belting and small tools, $1,606.77.

Cost of alterations in stone-shed, $652.11.

SAND.

Proposals were invited for furnishing 10,000 cubic yards of building sand, at the Government wharf at this place, loaded into boxes ready to be hoisted onto the wharf. Following is an abstract of the bids received:

Name and address of bidders.	Per cubic yard.
William Murray, The Dalles, Oregon	$0.99
John McDonald, The Dalles, Oregon	1.21
Borthwick & Fraine, Cascade Locks, Oregon	1.38
William Grant, Grant's Station, Oregon	1.48
Jos. T. Peters, The Dalles, Oregon	1.55
James O. Lyle, Lyle, Wash	5.60

The sample furnished with the bid of William Murray was from a sand-drift, some 30 feet above the river, and was utterly worthless for our purposes. All the other bids, considering the nature of the samples furnished, were thought to be exorbitant, and so all were rejected. Subsequently, 1,000 cubic yards of the kind offered at $1.38, which was thought to be as good as was obtainable, were bought in open market at $1 per cubic yard.

There seems to be little or no really good sand in this region. Careful search has been made from The Dalles down to this place without finding any. Whether it will

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be advisable to bring sand here from a long distance, as from California, can be told only after trying the sands from a distance with cement in competition with the sand obtainable here.

Experiments might well be instituted to determine this point.

WHARF.

The new wharf is located a few hundred feet above the upper entrance to the canal. It is 26 feet wide and 72 feet long. The floor is at reference (128), which is that of average high water, and is 32 feet above low water.

It is connected with the shore by a level roadway, 12 feet wide and 320 feet long, resting on pile-work. Underneath the wharf is an incline running to near low water, to permit landing at varying stages of the river. The contract price for the whole, constructed according to specifications, was $2,290. Besides the above, $20.85 were allowed the contractors for extra work. The total additional cost to the Government for inspection and for extra work in building a derrick, strapping fender-piles to wharf, securing caps to piles by dog-irons, etc., was $459.52.

Total cost of wharf, $2,770.37.

STONE-CUTTING.

Face stone for side wall of canal, 910 cubic yards.
Superficial cutting on above, 40,901 square feet.
Linear feet of base course cut, 161 feet 2 inches.
Linear feet of 2-foot course cut, 2,806 feet 5 inches.
Linear feet of 1-foot 10-inch course cut, 1,198 feet 7 inches.
Linear feet of 1-foot 8-inch course cut, 1,094 feet 9 inches.
Average cubic feet cut per man per day, 19.92 cubic feet.
Average square feet cut per man per day, 33 12 square feet.
Cost of cutting per cubic foot (stone-cutters' labor only), 17 cents.
Cost of cutting per square foot (stone-cutters' labor only), 10 cents.
Cost per cubic foot, including superintendence, handling, sharpening of tools, materials, etc., but exclusive of value of stone, 24 cents.
Cost per square foot, including above items, but exclusive of value of stone, 14.4 cents.
Cost per cubic yard, including value of rough dimension stone, $11.33.
Rough punched ashlar for lower course of caisson sill, 10 cubic yards.
Superficial cutting on above, 586 square feet.
Average number of square feet cut daily per man, 23.9 square feet.
Average number of cubic feet cut daily per man, 9.8 cubic feet.
Average cost of cutting per square foot (stone-cutters' labor only), 16.7 cents.
Average cost of cutting per cubic foot (stone-cutters' labor only), 40 cents.
Cost per square foot, including superintendence, sharpening of tools, materials, etc., but exclusive of value of stone, 17.7 cents.
Cost per cubic foot, including above items, but exclusive of value of stone, 43 cents.
Cost per cubic yard, including value of rough dimension stone, $15.21.

BOWLDER QUARRYING.

Amount of stone quarried for cutting	cubic yards	678.5
Amount of stone quarried for paving	do	323.8
Total		1,002.3
Cost of quarrying per cubic yard of stone obtained		$1.46

PAVING SLOPE ON RIGHT AT UPPER ENTRANCE.

Amount of dry stone pavement laid	cubic yards	1,193
Cost of pavement per cubic yard		$4.94

MISCELLANEOUS.

The timber framing supporting the large centrifugal pump, destroyed by fire at the time of the burning of the steamer *A. A. McCully*, has been rebuilt. The pump itself has been thoroughly overhauled and set into position. Two new 8-foot drive-wheels for carrying the steel wire drive-rope are now on hand, together with the necessary pulleys and belting, so that the pump can soon be put into working order when needed.

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The total cost of the repairs to the pump-station to date is $419.65.

In order to determine what fuel is best adapted for use in our hoisting-engines, from an economical stand-point, trials were made with seasoned fir, green fir, bituminous coal, gas coke from Walls End coal, gas coke from English cannel coal. Seasoned fir proved by far the most economical for use here.

A very great difference was shown between seasoned and unseasoned fir, from which the conclusion is drawn that it will always be well to provide an ample supply of seasoned wood.

The following statement shows the average number of hours worked per day for each month of the year:

Month.	Average hours worked per day.	Month.	Average hours worked per day.
July	20	January	1,507
August	311	February	1,047
September	189	March	1,339
October	863	April	844
November	2,236	May	288
December	2,036	June	356

The rain-fall, height of water, etc., for each month of the year are given in the following table:

Months.	Rain-fall.	Days on which rain or snow fell.	Average temperature 1 p. m.	Highest reading above extreme low water.		Lowest reading above or below extreme low water.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1886.							
July	0.56	6	72.6	117.4	102.7	108.9	90.9
August	0.06	2	75.0	108.7	90.5	102.5	81.5
September	2.93	8	69.5	102.3	81.1	99.2	76.4
October	4.72	16	58.4	99.1	76.3	97.1	73.7
November	3.38	13	47.8	97.3	73.9	95.7	72.0
December	20.94	27	45.2	98.4	75.5	95.6	71.9
1887.							
January	29.90	28	43.9	100.3	78.7	98.1	75.1
February	3.85	18	30.8	99.6	77.4	96.1	72.4
March	14.09	21	55.1	108.4	90.6	96.8	73.2
April	8.15	23	55.1	109.7	92.5	107.3	89.0
May	6.68	12	66.6	128.3	114.4	111.5	94.9
June	1.32	10	68.3	135.3	121.3	128.0	113.9
Total	96.58	183	57.3	135.3	121.3	95.6	71.9

NOTE.—Reading of adopted low water at head of canal, 96; at foot of canal, 72.

The annexed detailed statement shows the money expenditures and the cost of the various items of work during the year.

Very respectfully, your obedient servant,

W. YOUNG,
Captain of Engineers.

Capt. CHARLES F. POWELL,
Corps of Engineers.

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Annual report of expenses of Cascades Canal for the year ending June 30, 1887.

Designation of accounts.	Hired labor.	Contract work, office rent, hire of mules, washing, stumpage, etc.	Total payments for year's expenses.	Unpaid accounts.		Materials used.	Plant dropped by condemnation, affidavits, etc.	Proportion of stable expenses.	Proportion of sawing wood.	Proportion of transporting wood.	Transporting stone used.	Quarrying stone used.	Total.	Less accounts wholly or partly closed into other accounts.	Total cost for the year.
				Part of June pay-roll, 1887.	Stumpage on trees, hire of horses, services of F. L. Clerc, etc.										
Engineering, superintendence, etc	$2,500.37		$2,500.37	$347.18	$100.00	$88.62	$13.42	$1.49	$4.95	$1.77			$3,057.80		$3,057.80
Office expenses	2,230.73		2,230.73	162.36		110.68	9.66	1.49	5.30	1.78			2,522.00		2,522.00
Office expenses, Portland office	1,413.43	$131.25	1,544.68			131.42							1,676.10		1,676.10
Office expenses, Chief of Engineers		378.40	378.40										378.40		378.40
Hospital and sanitary expenses	874.24		874.24			29.96	.67						904.87		904.87
Stable expenses	396.12	49.20	445.32	38.09	21.67	949.09	168.35						1,622.52	$1,622.52	
Protection of property	2,135.29	12.58	2,147.87	158.18		50.31	121.12	$4.67	5.83				2,537.98		2,537.98
Maintenance of plant	5,205.57	42.70	5,248.27	398.36	42.67	2,164.63		312.51	22.78	4.68			8,193.90		8,193.90
Maintenance of quarters	597.86		597.86	25.82		441.47	48.82	43.41	96.97	12.18			1,266.53		1,266.53
Repairs to buildings	726.22		726.22	21.20		373.66		4.61					1,125.69		1,125.69
Repairs to pump and engine station	321.31		321.31			94.95		3.39					419.65		419.65
Repairs to fence	45.78		45.78			6.70							52.48		52.48
Extending and repairing water supply	28.57		28.57	5.50		28.16							62.23		62.23
Constructing blacksmith and machine shop	607.40		607.40			626.57		8.79					1,242.76		1,242.76
Constructing wharf	132.09	2,200.00	2,422.09			112.89		1.14					2,536.12		2,536.12
Constructing upright derrick No. 1	160.94		160.94			72.46		.85					234.25		234.25
Constructing upright derrick No. 10	128.47		128.47			42.95		.47					171.89		171.89
Constructing upright derrick No. 13				95.50		166.49		2.66					264.65		264.65
Constructing a tramway from stone-shed to wharf	660.99		660.99		50.16	145.58		9.80					875.53		875.53
Constructing fence	25.06		25.06			31.66							56.72		56.72
Constructing wing-wall on left of canal	430.98		430.98			22.39		.59					453.96		453.96
Constructing caisson recess	110.80		110.80			1.58		1.76					114.14		114.14
Excavating canal prism	27,938.68		27,938.68			7,051.34	527.86	145.85	203.65	26.80			35,894.18		35,894.18
Excavating at upper entrance to canal	4,361.21		4,361.21			231.13		10.81	34.45	21.92			4,659.52		4,659.52
Excavating at upper entrance to canal between Stations 7 and 12	213.45		213.45			10.16		2.10	1.40	1.29			228.40		228.40
Excavating for gate at Station 12	496.13		496.13			15.60		3.38	4.24	3.23			522.78		522.78
Excavating on left of canal for wing-wall	1,211.80		1,211.80			47.12		4.98	11.66				1,275.56		1,275.56
Excavating at lower entrance to canal below bulkhead	66.38		66.38			2.79		.90	.70				70.77		70.77

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Clearing away and piling stone at lower entrance to canal	3,291.79		3,291.79			178.68	3.50	13.30	17.05				3,504.32		3,504.32
Grading grounds on right of canal	8,606.95		8,606.95		51.00	702.22	165.50	714.60					10,239.77		10,239.77
Grading grounds on left of canal	1,698.56		1,698.56	15.35		146.02		153.63	10.60				2,024.16		2,024.16
Cutting stone for side-walls	4,847.56		4,847.56	975.20		172.42		16.17	16.25		$1,252.12	$3,173.50	10,453.22		10,453.22
Cutting stone for caisson sill				143.12		6.97		.96	.71		13.93	35.30	200.99		200.99
Paving slope of right bank above locks	1,140.21		1,140.21	374.12		61.23		9.64	10.24	1.94	936.78	3,364.94	5,899.10		5,899.10
Quarrying bowlders	1,455.44		1,455.44			16.62							1,472.06		1,472.06
Policing grounds	265.30		265.30	2.90				36.87					305.07		305.07
Sawing wood	402.58		402.58	5.52		5.48	23.10	14.07					450.75	450.75	
Roads	94.71		94.71	3.85		17.92		1.19					117.67		117.67
Putting up ice	40.83		40.83					15.24					56.07		56.07
Transporting wood from wharf	61.65		61.65			5.63		6.54	1.77				75.59	75.59	
Transporting sand from wharf	180.28		180.28			7.35		20.36	2.20				210.19		210.19
Transporting stone for cutting	99.49		99.49			49		4.30					104.28		104.28
Transportation and cartage		1,888.87	1,888.87		44.46								1,933.33		1,933.33
Traveling expenses		23.75	23.75		178.30								202.05		202.05
Telegrams		2.20	2.20										2.20		2.20
Mileage		228.16	228.16		7.20								235.36		235.36
Advertising		9.45	9.45										9.45		9.45
Printing		11.75	11.75										11.75		11.75
Notary fees		.50	.50										.58		.50
Repairs to bowlder dredge		4.50	4.50										4.58		4.50
Materials purchased		19,591.26	19,591.26		297.20								19,888.46	14,371.59	5,516.87
Plant purchased		6,968.98	6,968.98		117.78								7,086.76	1,719.33	5,367.43
Plant condemned and unapportioned							637.83						637.83		637.83
Total	75,214.22	31,633.55	106,847.77	2,772.25	910.44	14,371.59	1,719.33	1,622.52	450.75	75.59	2,202.83	6,573.74	137,546.81	18,239.78	119,307.03

Total payments, as shown by abstracts of disbursements	**$107,024.71**
Reserved by Chief of Engineers	**378.40**
Total payments	**107,403.11**
Less June pay-roll, 1886, paid during present year	**555.34**
Total payments for year's expenses, as shown by above statement	**106,847.77**

Total payments for year's expenses, as shown by statement	$106,847.77
Part June pay-roll, 1887, unpaid	2,772.25
Other unpaid accounts	910.44
Value of quarried stone used—quarried and transported in previous years	8,776.57
Total cost for the year, as shown by the above statement	**119,307.03**

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Annual report of expenses of Cascades Canal for the year ending June 30, 1887.

Designation of accounts.	Hired labor.	Contract work, office rent, hire of mules, washing, stumpage, etc.	Total payments for year's expenses.	Unpaid accounts.		Materials used.	Plant dropped by condemnation, affidavits, etc.	Proportion of stable expenses.	Proportion of sawing wood.	Proportion of transporting wood.	Transporting stone used.	Quarrying stone used.	Total.	Less accounts wholly or partly closed into other accounts.	Total cost for the year.
				Part of June pay-roll, 1887.	Stumpage on trees, hire of horse, services of F. L. Clerc, etc.										
Engineering, superintendence, etc	$2,500.37		$2,500.37	$347.18	$100.00	$88.62	$13.42	$1.49	$4.95	$1.77			$3,057.80		$3,057.80
Office expenses	2,230.73		2,230.73	162.36		110.68	9.66	1.49	5.30	1.78			2,522.00		2,522.00
Office expenses, Portland office	1,413.43	$131.25	1,544.68			131.42							1,676.10		1,676.10
Office expenses, Chief of Engineers		378.40	378.40										378.40		378.40
Hospital and sanitary expenses	874.24		874.24			29.96	.67						904.87		904.87
Stable expenses	396.12	49.20	445.32	38.09	21.67	949.09	168.35						1,622.52	$1,622.52	
Protection of property	2,135.29	12.58	2,147.87	158.18		50.31	121.12	94.67	5.83				2,537.98		2,537.98
Maintenance of plant	5,205.57	42.70	5,248.27	398.36	42.67	2,164.63		312.51	22.78	4.68			8,193.90		8,193.90
Maintenance of quarters	597.86		597.86	25.82		441.47	48.82	43.41	96.97	12.18			1,266.53		1,266.53
Repairs to buildings	726.22		726.22	21.20		373.66		4.61					1,125.69		1,125.69
Repairs to pump and engine station	321.31		321.31			94.95		3.39					419.65		419.65
Repairs to fence	45.78		45.78			6.70							52.48		52.48
Extending and repairing water supply	28.57		28.57	5.50		28.16							62.23		62.23
Constructing blacksmith and machine shop	607.40		607.40			626.57		8.79					1,242.76		1,242.76
Constructing wharf	132.09	2,200.00	2,422.09			112.89		1.14					2,536.12		2,536.12
Constructing upright derrick No. 1	160.94		160.94			72.46		.85					234.25		234.25
Constructing upright derrick No. 10	128.47		128.47			42.95		.47					171.89		171.89
Constructing upright derrick No. 13				95.50		166.49		2.66					264.65		264.65
Constructing a tramway from stone-shed to wharf	669.99		669.99		50.16	145.58		9.80					875.53		875.53
Constructing fence	25.06		25.06			31.66							56.72		56.72
Constructing wing-wall on left of canal	430.98		430.98			22.39		.59					453.96		453.96
Constructing caisson recess	110.80		110.80			1.58		1.76					114.14		114.14
Excavating canal prism	27,938.66		27,938.68			7,051.34	527.86	145.85	203.65	26.80			35,894.18		35,894.18
Excavating at upper entrance to canal	4,361.21		4,361.21			231.13		10.81	34.45	21.92			4,659.52		4,659.52
Excavating at upper entrance to canal between Stations 7 and 12	213.45		213.45			10.16		2.10	1.40	1.29			228.40		228.40
Excavating for gate at Station 12	496.13		496.13			15.50		3.38	4.24	3.23			522.78		522.78
Excavating on left of canal for wing-wall	1,211.80		1,211.80			47.12		4.98	11.66				1,275.56		1,275.56
Excavating at lower entrance to canal below bulkhead	66.38		66.38			2.79		90	70				70.77		70.77

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Clearing away and piling stone at lower entrance to canal	3,291.79		3,291.79			178.68	3.50	13.30	17.05				3,504.32		3,504.32
Grading grounds on right of canal	8,606.95		8,606.95		51.00	702.22	165.50	714.60					10,239.77		10,239.77
Grading grounds on left of canal	1,698.56		1,698.56	15.35		146.02		153.63	10.60				2,024.16		2,024.16
Cutting stone for side-walls	4,847.56		4,847.56	975.20		172.42		16.17	16.25		$1,252.12	$3,173.50	10,453.22		10,453.22
Cutting stone for caisson sill				143.12		6.97		.96	.71		13.93	35.30	200.99		200.99
Paving slope of right bank above locks	1,140.21		1,140.21	374.12		61.23		9.64	10.24	1.94	936.78	3,364.94	5,899.10		5,899.10
Quarrying bowlders	1,455.44		1,455.44			16.62							1,472.06		1,472.06
Policing grounds	265.30		265.30	2.90				36.87					305.07		305.07
Sawing wood	402.58		402.58	5.52		5.48	23.10	14.07					450.75	450.75	
Roads	94.71		94.71	3.85		17.92		1.19					117.67		117.67
Putting up ice	40.83		40.83					15.24					56.07		56.07
Transporting wood from wharf	61.65		61.65			5.63		6.54	1.77				75.59	75.59	
Transporting sand from wharf	180.28		180.28			7.35		20.36	2.20				210.19		210.19
Transporting stone for cutting	99.49		99.49			49		4.30					104.28		104.28
Transportation and cartage		1,888.87	1,888.87		44.46								1,933.33		1,933.33
Traveling expenses		23.75	23.75		178.30								202.05		202.05
Telegrams		2.20	2.20										2.20		2.20
Mileage		228.16	228.16		7.20								235.36		235.36
Advertising		9.45	9.45										9.45		9.45
Printing		11.75	11.75										11.75		11.75
Notary fees		.50	.50										.58		.50
Repairs to bowlder dredge		4.50	4.50										4.58		4.50
Materials purchased		19,591.26	19,591.26		297.20								19,888.46	14,371.59	5,516.87
Plant purchased		6,968.98	6,968.98		117.78								7,086.76	1,719.33	5,367.43
Plant condemned and unapportioned							637.83						637.83		637.83
Total	75,214.22	31,633.55	106,847.77	2,772.25	910.44	14,371.59	1,719.33	1,622.52	450.75	75.59	2,202.83	6,573.74	137,546.81	18,239.78	119,307.03

Total payments, as shown by abstracts of disbursements		$107,024.71	
Reserved by Chief of Engineers		378.40	
Total payments		107,403.11	
Less June pay-roll, 1886, paid during present year		555.34	
Total payments for year's expenses, as shown by above statement		106,847.77	

Total payments for year's expenses, as shown by statement	$106,847.77
Part June pay-roll, 1887, unpaid	2,772.25
Other unpaid accounts	910.44
Value of quarried stone used—quarried and transported in previous years	8,776.57
Total cost for the year, as shown by the above statement	119,307.03

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COMMERCIAL STATISTICS.

The Cascades of the Columbia River are in the collection district of Willamette. The nearest port of entry is Portland, Oregon, 63 miles distant by river. The nearest light-houses and works of defense are at the mouth of the Columbia River, 150 miles distant. The amount of revenue collected at Portland for the year ending June 30, 1887, is $205,873.33.

Upper Columbia River grain rates, rail, to Portland, Oregon.

Place.	Distance.		Car-load rates per 2,000 pounds.
	Rail.	River.	
	Miles.	*Miles.*	
Dalles	87	110	$3.40
Celilo	101	124	3.60
Grants	111	134	3.80
Umatilla Junction	187	206	4.40
Wallula Junction	214	229	4.80
Walla Walla	245	.....	5.00
Ainsworth	228	240	6.00
Riparia	301	306	6.00
Lewiston	378	376	6.00

Principal river country shipments passing Cascade locks west, by rail.

[Compiled at Engineer office, from commercial reports.]

Years.	Wheat.	Flour.	Oats.	Barley.	Mill-stuff.	Wool.	Hides.		Flax-seed.	Ore.	Live stock.
	Centals.	*Barrels.*	*Centals.*	*Centals.*	*Centals.*	*Pounds.*	*Pounds.*	*Cars.*	*Sacks.*	*Sacks.*	*No.*
1884	1,856,392	150,719	29,375	8,569	31,379	7,168,953	799,364	.....	36,523	18,592	(*)
1885	4,210,092	164,322	38,520	124,672	25,430	9,877,866	1,064,839	.....	69,856	2,722	(*)
1886	3,737,370	105,508	1,495	45,465	14,608	11,755,566	1,045,359	.....	65,889	73,908	(*)
1887 (5 mos.)	456,478	45,143	1,000	4,182	6,748	7,956,711	896,677	5	2,486	.....	2,070

* Not reported.

Principal river country shipments passing Cascade locks east, by rail.

[Compiled from lumber mills statements and Portland Board of Trade reports and records.]

Year.	Salmon.				Wool.		Hides.		Hops.	
	Cases.	Barrels.	Packages.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1884	1,434,801	320	933	$803,543	2,582,453	$395,572	220,142	$24,453	3,154,531	$449,842
1885	2,224,701	467	728	843,152	5,723,249	814,916	205,905	17,932	5,536,817	448,527
1886	280,869	237	306	1,501,290	7,876,698	1,417,985	348,206	47,250	6,404,179	1,058,305

Years.	Green fruit.		Furs.		Lumber.		Laths.		Shingles.	
	Boxes.	Value.	Pounds.	Value.	M feet.	Value.	M.	Value.	M.	Value.
1884	2,955	$1,600	.....	.....	.....	.....	.....	.....	.....	.....
1885	17,406	11,765	24,382	$22,725	.....	.....	.....	.....	.....	.....
1886	8,709	6,850	59,648	62,375	37,929	$455,146	2,846	$4,724	24,127	$60,319

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T T 7.

IMPROVEMENT OF CHEHALIS RIVER, WASHINGTON TERRITORY.

The project consists in annual snagging operations below Claquato, 82 miles from the river's mouth, at an estimated cost of $5,000. The total appropriation since adoption of this plan in 1882 is $8,000. The amount expended thereon is $5,764.06.

A snagging party, working from land and a small scow, commenced operations in early June of this year on the upper river at Chehalis station of the Northern Pacific Railroad. The party worked to near the Chehalis Reservation Agency, about 16 miles. Two hundred and ninety-three large snags or pieces of drift were removed and masses of drift at jams loosened or burned. The work is to be continued down-stream, reopening the channel to good water, a little above Montesano, the head of coasting navigation, and removing a few snags in the channel below Montesano.

There has been no steam navigation above Elma, the head of tide, about 12 miles above Montesano. There is no steamer on the river suitable for navigating the upper river. The estimate for next year is for work below Elma.

APPROPRIATIONS.

Act August 2, 1882	$3,000
Act July 5, 1884	2,500
Act August 5, 1886	2,500
Total	8,000

Money statement.

July 1, 1886, amount available		$10.69
Amount appropriated by act approved August 5, 1886		2,500.00
		2,510.69
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$611.71	
July 1, 1887, outstanding liabilities	629.04	
		1,240.75
July 1, 1887, amount available		1,269.94
Amount (estimated) required for continuing existing project		8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

COMMERCIAL STATISTICS.

Chehalis River is in the collection district of Oregon. The amount of revenue collected at its port of entry for the year ending June 30, 1887, is $83,051.06. The nearest light-house is on Toke Point, at the entrance to Shoalwater Bay, 16 miles south of Gray's Harbor, into which the Chehalis empties.

Openings have been made through two large jams in the Upper Chehalis and the worst snags and drift heaps removed from there to the head of coasting navigation. Logging and small-boat navigation have been facilitated.

Immigration and capital have been largely directed for the last two years to the Lower Chehalis and Gray's Harbor country. Lumbering at the mouth of the river and at the upper part of the harbor and farming along the river are the main industries. A fleet of vessels plies between the saw-mills and San Francisco and a steam coaster between Montesano and Astoria.

The entrance to the harbor is excellent, but some bars exist between the entrance and the saw-mills, which limit the draught of vessels used and cause detentions to ones in the trade.

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TT8.

IMPROVEMENT OF THE SKAGIT, STEILAQUAMISH, NOOTSACK, SNOHOMISH, AND SNOQUALMIE RIVERS, WASHINGTON TERRITORY.

The project consists in annual snagging and moderate bar scraping by a regular equipped snagboat for light-draught navigation on an aggregate length of river of about 250 miles, at an originally estimated cost of $25,000 as the first cost of the boat and $10,000 annually thereafter for her operation. The amount appropriated on this project is $40,000, and the amount expended thereon is $35,971.41.

Under the appropriation of 1886, the snagboat, which had been laid up for nineteen months on account of want of funds for her operation, was, after some limited repairs in September, put in commission and sent to the Nootsack River, stopping on her way at the lower Snohomish River, where she removed 66 large snags. On the Nootsack, the snagboat worked from the mouth to Lynden, about 19 miles, and the present head of navigation. She removed 781 snags and cut or partly cut from the bank 97 overhanging trees. A fairly good channel was made. No work had previously been done on this part of the river.

The boat was withdrawn in December on the approach of a freeze-up, and laid up in the Snohomish River.

It is expected this summer and fall, as soon as the summer high water recedes sufficiently for advantageous work, to send the boat to the Snoqualmie River, where no operations have yet been conducted.

Under the present project partial work has been done on four of the rivers covered by the project. On account of this want of completeness and the accumulation of obstructions during long suspensions of work, next year's estimate for operating expenses is double the annual amount expected by the estimate at the adoption of the project.

The estimates for this improvement are small, and the benefit to be obtained is large, proportionately. In the absence of railroads, and even wagon roads, the rivers are the only routes of travel and transportation. The steamer charges are high, and their routes are limited on account of drift obstructions. Accumulation of such obstructions renders their removal more expensive.

It appears to me that appropriations for snagging and similar river work, necessarily of a temporary character, should be general, according to needs, and continuous, as they are for the operation and repair of locks and canals, and not be dependent upon the annual river and harbor bill.

The aggregate length of these rivers, on which navigation can be readily improved and extended, is about 250 miles. The lower parts of the valleys are adapted to agriculture; in the upper portions are tracts of fine timber and reported veins of coal and iron.

Present industries are logging and farming. Grain, vegetables, hay, and dairy products are exported by river steamers to Seattle and other towns on Puget Sound.

The items of the estimate for next year are:

Completion of snagboat and outfit	$5,000
Cost of work on five rivers, at $4,000	20,000
Three years' reserve for fund for replacement of plant at end of ten years	6,000
	31,000

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APPROPRIATIONS.

Act June 14, 1880, Skagit River	$2,500
Act August 2, 1882, Skagit, Steilaquamish, Nootsack, Snohomish, and Snoqualmie rivers	20,000
Act July 5, 1884	10,000
Act August 5, 1886	10,000
Total	42,500

The rivers are in the collection district of Puget Sound. The nearest port of entry is Port Townsend, Wash. The nearest light-houses are on Puget Sound. It is not practicable to obtain information about the amount of revenue collected.

Money statement.

Amount appropriated by act approved August 5, 1886	$10,000.00	
		$9,880.61
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	5,987.02	
July 1, 1887, outstanding liabilities	64.05	
		6,051.07
July 1, 1887, amount available		3,829.54
Amount (estimated) required for continuing existing project		31,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

T T 9.

GAUGING WATERS OF THE COLUMBIA RIVER AND PRINCIPAL TRIBUTARIES.

The object here is to operate an automatic gauge at Astoria and maintain staff-gauges above for pilots' information and for record of tides and stages of river, one service of the Astoria gauge being to show the condition of the bar at the mouth of the Columbia River with regard to roughness. It is also intended to measure the tidal and river volumes. The total amount expended since the service was begun in 1883 is $2,339.30.

Pilots' gauges of the Lower Willamette and Columbia Rivers were generally replaced by new staffs; the gauge at Martin's Bluff was carried away and not renewed. Gauges were established at Callahan's Wharf and on the Lower Willamette, and at Henrici's Landing, and on the fish-trap next above Walker's Island Bar, Columbia River, making fourteen pilots' gauges along the ship-channel. The zeros of the gauges were set at the morning low tide of October 6, 1886, the lowest water during navigation recorded; this change required a depression of the old Columbia River gauges of 1.3 feet. Notices were issued to masters and pilots of the changes and of the new gauges.

Day-time highest and lowest staff-gauge readings were observed during the year at North Portland, and for a few months at St. Johns, Coon Island, and St. Helens; also daily readings at a stated hour at Salem, on the Upper Willamette River. Similar readings in connection with the canal work were taken at the head and foot of the Cascades Canal.

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A float-gauge was established at Portland and operated for a few months for day and night readings, as were also the float-gauges at Columbia City and Mount Coffin.

The Astoria self-registering gauge was run from November 15; a second gauge of the same kind was there operated to furnish daily sheets of a large scale, which were posted for showing the sea-bar condition and height and time of tides; this service was increased subsequently to include a daily-bulletin notice of the bar condition, in words, as very rough, rough, moderate, smooth, very smooth.

The extreme low water of last fall, lower than any expected, was followed this summer by a Columbia flood of unusual height, seriously interfering with business at and below Portland. The river at the head of the Cascades Canal rose 39.3 feet above low water, or about 7 feet above mean flood; at the foot of the canal, 49.3 feet; at Portland, 25.4 feet; Columbia City, 21.7 feet; and at Mount Coffin, 16.6 feet. Under a good service of gauging, including the upper tributaries of the Columbia, the approach and probable height of the flood could have been published daily at Portland, to the great advantage of commerce.

The expense of the service of gauging and water-gauges is small. It has been curtailed for the want of funds, and is likely to be any year when dependent upon the annual river and harbor bill. The service should be continuous, and to insure that, I judge, appropriation therefor should be continuous according to the needs of the service, the same as appropriations are for the repair and operation of canals and locks. The pilots' gauges are readable from passing vessels, and are placed above and below the bars of the ship-channel and at convenient places; the staffs need to be renewed at least twice a year.

Pilots commend this inexpensive service. The Astoria automatic gauges are considered important by bar navigators. I have seen a steam-ship master decline to go to sea on account of the record showing a very rough bar. The other part of the project has less direct benefit on commerce and navigation, but one of much value.

APPROPRIATIONS.

Act August 2, 1882, gauging waters of the Columbia River from Astoria to the bar	$500
Act July 5, 1884, gauging waters of the Columbia River and principal tributaries	1,000
Act August 5, 1886, gauging the waters in the Columbia River	1,000
Total	2,500

Money statement.

July 1, 1886, amount available		$4.73
Amount appropriated by act approved August 5, 1886		1,000.00
		1,004.73
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$844.03	
July 1, 1887, outstanding liabilities	115.50	
		959.53
July 1, 1887, amount available		45.20
Amount (estimated) required for continuing existing project		5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

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T T 10.

PRELIMINARY EXAMINATION OF SIUSLAW RIVER AND BAR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 27, 1886.

SIR: I have the honor to transmit herewith the report of the preliminary examination of the Siuslaw River and Bar, Oregon, lately made by Lieut. Edward Burr, Corps of Engineers, and to add some statements in relation thereto.

The examination was required by Department notice to me of last October 28, for compliance with the river and harbor act of August 5, 1886.

The Siuslaw empties into the sea 44 miles north of the Coos Bay entrance, and nearly the same distance south of Yaquina Bay, the nearest places to the mouth of the Siuslaw where works for improving entrances have been undertaken.

The Umpqua River, which admits coasters, and where an examination is also ordered, lies about midway from Coos Bay to the Siuslaw.

The Siuslaw region is effectually inclosed by the coast mountains on the east, and by their spurs on the north and south. The bar at the mouth of the river shuts out all but small vessels.

An insecure wagon road leads over the mountains from Eugene City, at the head of the Willamette Valley. A weekly mail goes this way. Most of the communication and a tri-weekly mail are by wagon on the beach from the mouth of the Umpqua.

The present industry is salmon fishing and packing. The value of last season's pack is about $15,000. Good timber and some grazing and agricultural land are reported.

It is claimed if the entrance were deepened that a railroad would be built from Eugene City, on the Oregon and California Railroad, and to a connection with the east side part of the Willamette Valley narrow-gauge system.

The population of the Siuslaw region is estimated by Lieutenant Burr at 250. Other representation places it from 750 to 1,000. There are three settlements on the river; the main one, Florence, 4 miles from the mouth, has ten houses and about twenty-five residents.

An engineer examination was made of the Siuslaw in October, 1880, for compliance with the act of June 14, 1880. It was then represented by the residents on the Siuslaw that no improvement was required, but that buoyage of the entrance, its actual survey, and an official declaration of the depth were desired. The engineer in charge recommended a thorough survey of the harbor and bar for information of the shipping public, at a cost of $1,500, and stated that he did not think proper to recommend any appropriation for the commencement of an improvement at the entrance.

A survey from the entrance to Florence was made in 1883 by the Coast Survey. The preliminary sheet, scale $\frac{1}{10000}$, shows that the controlling depth of this part is 10 to 12 feet, and that the channel depths are generally from 12 to 15 feet, low water. Nearer the entrance the channel depths are from 3 to 5 fathoms. The distance between the 12-foot curves will average about 700 feet, and between the low-water banks, 900 feet. The sheet shows some soundings on the bar, but not enough to develop it, but still enough to show a very shoal bar. The controlling channel depth is given as 5 feet at low water, or 11 to 12 feet at mean high water. The accuracy of these results is disputed.

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No other survey whatever has been made of any part of the Siuslaw River. The Siuslaw people now much desire a new and more complete survey, buoyage of the channel, and works to hold it in one place.

The channel readily shifts, but generally works north for a few years by the growth of a south spit, and then suddenly breaks through the spit. In 1883 it was to the north. It is now, and has been for a year, to the south, and about a mile distant from the former position.

A few years ago the Coos Bay steamships used to make occasional trips to the Siuslaw during favorable weather and when loaded lightly. Vessel records kept for this office show that the steamers on such trips drew 10 feet. This indicates a low-water channel depth of about 8 feet at least. During the last year the small coasters, *Kate and Ann* and *Mischief*, drawing from 7 to 9 feet loaded, have been to the Siuslaw.

I understand, from a limited study of the entrance, that the channel may not only shift, but that the depths may vary considerably at different times. That is characteristic of the small entrances on the Oregon coast. At the Siuslaw the range of channel depths, at different times, may be as much as from 5 to 9 feet. I judge that annual surveys, until works for permanency of channel are built, would be needed for the use of masters and vessel insurers about as much as a single survey is needed now for that purpose.

The matter of buoyage belongs in another department.

Concerning an improvement, I report that the Siuslaw is not now worthy of improvement. Inside of the entrance no improvement is needed for present nor prospective demands of commerce. The river is good enough. A permanent deepening of the bar channel is desirable. It would be costly, and I am not assured that it is now necessary, neither that it certainly will be necessary for several years. The limit of improvement in depth is something like 10 feet at low water, or 16 to 17 feet at mean high water. I do not believe this would warrant the construction of a railroad from the interior for a shipping point. Small coasters from the Columbia River, Yaquina Bay, or Coos Bay, will take care of the present Siuslaw trade. Lumbering on the Siuslaw may, in the future, be a reason for improving the entrance. This industry, at places more favored than the Siuslaw with an improved entrance, has been depressed for several years, and is still so.

The cost of a detailed survey of the entrance and a prompt issue of charts for use in the coasting trade would be $2,000, and if the survey were extended from Florence to the head of tide, as desirable, $1,000 additional. Each survey of the entrance, and one of the river inside, would be useful when the time comes to project a plan of improvement of the mouth.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 10, 1886.

SIR: I have the honor to submit the following report of an examination of the Siuslaw River and Bar, made in accordance with your instructions:

The Siuslaw River rises east of the Coast Range of mountains, about 50 miles, in a straight line, from the coast, and flowing, in a general direction, a little north of west, it enters the ocean about 22 miles north of the Umpqua River, draining a terri-

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tory of about 450 square miles. My personal examination extended from the bar about 24 miles up-stream to a point half a mile above the head of tide.

At the foot of the rapids the river is about 150 feet wide and has the usual characteristics of mountain streams, being rapid, full of rocks and bowlders, and with a small depth of water at the usual stages. Its freshets occur during the rainy, winter season, and are of magnitude enough for the driving of logs, the only possible use to which the river could be put. The only tributary of any importance seems to be Lake Creek, which enters the river some 8 miles above the head of tide.

From the head of tide to the bar the river is similar to other tidal streams. The tide at the bar has a mean rise of about 6½ feet, and at the foot of the rapids a rise of nearly 3 feet. To within a mile of the rapids the river has a depth ample for all purposes for which it would be used, having, as I was told, a depth of nowhere less than 16 feet. From this point to the head of tide a small steamboat would probably have little difficulty in navigating. At the head of the tide the river has a width of about 250 feet and this width gradually increases to the North Fork, where it becomes about half a mile. From there it decreases again, being about 1,000 feet wide at Florence and at the entrance.

At the head of tide the hills rise abruptly from the banks of the river to a height of 600 or 700 feet, but gradually become lower as they approach the coast, until they shade into the sand-hills. The valley between these hills has a variable width, being sometimes half to three-quarters of a mile wide, and is composed of bottom and tide lands already nearly all taken up by settlers.

The entrance from the sea is between sand-hills of small elevation and without prominent landmarks, the nearest prominent point being Cape Perpetua, 7 miles to north.

The channel on the bar lies nearly due east and west, pointing towards a ridge of low sand-hills, but immediately turns abruptly to the south. This fact, and the absence of landmarks, makes it very difficult for navigators to make out the entrance from at sea.

The bar is of the sand foundation usual on this coast and is without rocks. Both headlands are of sand, the north head being the more prominent. The river bluff on the south side comes down to opposite Florence, about 4 miles from the entrance, and is continued from there to the south head by a range of bare sand-hills from 50 to 100 feet high, and composed of shifting sand. The south head, however, is low, and is said not to have changed its position or shape, so far as known.

The river bluffs on the north side terminate at the North Fork, about 6 miles from the entrance. The remainder of the north bank is composed of sand-hills covered with a growth of brush and scrub timber and with an underlying stratum of what is locally called "cement." This cement is composed of sand and shells, slightly cemented together, soft enough when in position to be cut by a spade, but more stable than the sand in its resistance to the tide currents, giving a bluff bank with deep water close in. It lies at about the level of high water, and containing stumps of trees in their original positions, is probably the soil of what were tide lands before the sand accumulated upon it. Due to this cement, the north bank is much more stable than south bank.

The channel on the bar is a very variable one both as to depth and as to position. It has its greatest depth in the summer and least in the winter, when the southwest storms bank up the sand at its outer entrance where it points toward the southwest. I was told of depths varying from 9 to 16 feet at low water, and the actual depth is probably 10 or 12 feet. The Coast Survey examination made in 1883 shows a depth at mean low water of but 5 feet, but the correctness of this is disputed. Vessels drawing 12 feet have passed in and out over the bar.

The channel varies its position between the heads on the north and the south of the entrance. At the time of the Coast Survey examination in 1883—the last, and probably the only survey made of the entrance—it was well to the northward with a long spit extending north from the south head. During the winter of 1885–'86 the channel broke out across the spit, forming, for a time, two channels; but during the summer of 1886 the north channel closed completely, and at present the sand-spit, bare at high water and covered with drift, is connected at low water with the north head.

The channel, so I was told, goes through its cycle of changes in seven or eight years. Breaking through the south spit close to the south head, it slowly works its way to the north until the route for the escape of the tidal flow becomes so long that the pressure on the spit, caused by the banking up behind of the water in this long channel, due to the friction of the current, becomes so great as to break through the spit and form a second, shorter, narrower, but deeper, channel. The old channel then closes, the new one gradually lengthens and widens and goes through the same cycle again.

I transmit herewith a copy of the chart of the Coast Survey examination of 1883, and a sketch showing approximately the condition of the entrance at the time of my

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examination. The bar was too rough to permit of going over it in the only boat at hand (a row-boat), but by landing at low tide on the sand-spit and walking to the outer end of it, a fair idea of the entrance was obtained.

The country tributary to the Siuslaw River was an Indian reservation until 1876, when it was opened up to settlement, but settlers have since been only slowly coming in, and the country is still undeveloped. The population is estimated at about 250. There is but one settlement on the river—Florence—with about 10 houses and a population of about 25. There are two other post-offices on the river, one at Acme, at the mouth of the North Fork, and the other at Neeley's, the head of tide. There is talk of building a railroad from Eugene City, but conditional to the improvement of the entrance.

Mails are brought tri-weekly from Gardiner, on the Umpqua, by beach-wagon, and once a week by carrier overland from Eugene City.

The only means of transportation in and out of the country is by these two routes and by means of an occasional visit from one of the small coasting vessels. The Coos Bay steamers *Arcata* and *Coos Bay* have been in the river, and the steam-schooners *Kate and Anna* and *Mischief* make irregular visits. Other coasters come in occasionally. Vessels will not visit the river unless guaranteed a cargo both in and out, and insurance and charters are very high on account of the lack of information with regard to the entrance, and on account of the channel not being buoyed. The people claim that if the entrance were surveyed, buoyed, and improved, so as to furnish an outlet for the products of the country, that capital would come in to develop it, and reasonable rates of insurance could be had on cargoes. They would expect only the class of vessels that visit other coast harbors, with a draught of about 12 feet, and think that these vessels could be induced to visit the river if the entrance were surveyed and buoyed, and if a jetty were built to hold the channel in one position.

The salmon fishery is the principal industry of the country. The June run of salmon is small, but the fall run is very large. There are at present two small salteries and one small cannery on the river. The pack this season was about 1,500 cases and 2,200 barrels. It is expected that next year the cannery will be enlarged and one of the salteries changed to a cannery.

There is not much timber in sight from the river, the country having been partially burnt over by the great fire of 1846. I was told, however, of large quantities of fir and cedar timber on the headwaters and in the gulches back from the river. There is a small saw-mill at Acme, which supplies the local trade, and there is no outlet for any other.

The bottom and tide lands in the valley are capable of producing agricultural and dairy products.

No survey has been made of the river excepting the Coast Survey examination of 1883, and the entrance has since changed to such an extent as to require a new survey. I think the entrance worthy of a survey, and suggest that it be so recommended. This survey might include the river as far as the North Fork. The time in the latter part of May and early part of June is said to be the best time for such work, as that is about an interval between the cessation of the winter southwest winds and the beginning of the summer northwest winds, and the bar is then the smoothest. Such a survey could be made either from a steam-tug or a whale-boat, but either one would have to be taken there, as none are in the river. The cost of this survey is estimated at $1,500.

Very respectfully, your obedient servant,

EDW. BURR,
First Lieutenant of Engineers.

Capt. C. F. POWELL,
Corps of Engineers.

TT 11.

PRELIMINARY EXAMINATION OF NEHALEM BAY AND BAR, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 29, 1886.

SIR: I have the honor to transmit herewith the report of a preliminary examination of the Nehalem River and Bar, Oregon, lately made by Lieut. Edward Burr, Corps of Engineers.

The examination was required by Department notice to me of October 28 last, for compliance with the river and harbor act of August 5, 1886.

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This is the fourth engineer report of an examination of the Nehalem. Neither of the former reports recommended an improvement. They are given on pages 639 and 2,409 respectively, of the Report of the Chief of Engineers for 1876 and 1885, or in Senate Ex. Doc. No. 42, Forty-fourth Congress, first session.

Surveys of the lower portion of the river were made by the Coast Survey in 1868 and 1875, which did not include, however, soundings upon the bar, because, I judge, of its shoalness; breakers are shown on the maps at the sea-bar from shore to shore, and depths there are indicated to be something less than 6 feet at low water; no measure is given of how much less. Descriptions of the river and its bar and statements of the traffic of its region are given in the first and third reports named above and in Lieutenant Burr's report.

In my opinion the Nehalem River and Bar are not now worthy of improvement.

No improvement giving easy access to the river for the medium-sized coasters is practicable at moderate cost of coast works. The present traffic does not warrant even this moderate cost. Tillamook Bay, having a good harbor and entrance for coasters and a wagon-road from the interior, is 8 miles from the Nehalem, and connected by a low-tide beach wagon-road; there are also two traveled trails north to the Columbia River. When traffic warrants the investment, wagon-roads and then a railroad will probably be built from the Columbia River to the Nehalem country.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

REPORT OF LIEUTENANT EDWARD BURR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, December 27, 1886.

SIR: I have the honor to submit the following report of an examination of the Nehalem Bay and Bar, made in accordance with your instructions:

This entrance has already been the subject of two reports: one made February 28, 1876, by Maj. John M. Wilson, Corps of Engineers, and contained in Ex. Doc. No. 42, Forty-fourth Congress, first session; the other made October 22, 1884, by yourself, and contained in Ex. Doc. No. 71, Forty-eighth Congress, second session. Reference is made to the latter for a description of the river and its entrance, to which little can be added.

At the time of my visit to the Nehalem it was not possible to get out upon the bar, as the sea was breaking entirely across the entrance, and there was, besides, nothing but a row-boat available.

I am under the impression that there is a very small depth of water on the Nehalem Bar. No white man has ever sounded across the bar so far as I could learn. An Indian is said to have done so and reported 8 feet at low water. But parties interested in small steam-coasters, having examined the entrance with the idea of entering there, declined to do so. Yet an employé of one of these coasters informs me that his vessel enters Nestucca Bay, where the depth on the bar is about 3 feet at low water. Again, on one day that I was at the Nehalem Bar the sea was comparatively smooth, and with but a small surf on the beach. Yet across the Nehalem entrance, at low water, the sea broke almost as heavily as on the beach.

The river flows southward parallel to the beach for some 2 miles and is separated from it by a narrow sand-spit. The entrance seems to be working still farther to the south, cutting away the river bank. The channel on the bar is almost a continuation of the river channel above it, and appears to extend through the breakers at a very acute angle to their general line.

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The entrance might be improved by a jetty built somewhere above it, but there is nothing on the river or bay that will warrant any present expenditure for surveys or improvement.

There are but few settlers on the Nehalem. Plenty of timber, and some coal, similar to Coos Bay coal, are reported. Some salmon fishing was done on the river during 1886, and the fish were carried to Tillamook Bay, 8 miles south, by wagon, for packing.

Very respectfully, your obedient servant,

EDW. BURR,
First Lieutenant of Engineers.

Capt. C. F. POWELL,
Corps of Engineers.

T T 12.

PRELIMINARY EXAMINATION OF COQUILLE RIVER, BETWEEN COQUILLE CITY AND MYRTLE POINT, OREGON.

UNITED STATES ENGINEER OFFICE.
Portland, Oregon, January 29, 1887.

SIR: I have the honor to offer the following report of a preliminary examination of the Coquille River from Coquille City to Myrtle Point, Oregon, as required by Department orders for compliance with the river and harbor act of August 5, 1886.

The Coquille River is formed by the union of the North, Middle, and South Forks, which rise in the Coast Range, and after very circuitous routes towards the sea, and after receiving numerous branches, unite about 40 miles from the mouth of the river. Myrtle Point, the present head of navigation, and near the junction of the forks and Catching Creek, is a small thriving center of an agricultural region, and is the distributing and receiving point for the settlements, farms, and ranges which extend along the fertile valleys to the foot-hills.

Twelve miles down-stream is Coquille City, the principal place on the river, and the head of coasting navigation.

The mouth of the river is on the southern Oregon coast, between Coos Bay and Port Orford. A Government improvement is in progress at the mouth, which already affords a fairly good channel for the small lumber vessels which ply between the lower river and San Francisco.

No appropriation has been applied to the river above the mouth. The act of August 2, 1882, permitted $2,000 of the appropriation to be used, in the discretion of the Secretary of War, for removing snags from the upper river, but it was then considered judicious to apply the whole amount on the work already commenced.

The industries of the lower river are lumbering, fishing, and vessel-building, farm products for which are mostly drawn from the region above Coquille City. Wool, butter, skins, hams, potatoes, eggs, and barks are also shipped from this region on the lumber vessels.

There are some drift and rock obstructions between Coquille City and the mouth. A river improvement ought to include this reach as well as the one above.

Two light-draught steamers ply between Coquille City and Myrtle Point; one makes a daily trip, and the other runs tri-weekly. The steamers experience difficulty at the low stage of summer and early fall, on account of snags and sunken drift and shoaling caused by the latter; at times the steamers end their route a mile below Myrtle Point. Formerly the river was good, and I am told that steamers have ascended to the head of tide above Myrtle Point, and that a coaster has loaded

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at Norway, between Coquille City and Myrtle Point. The decay of the channel results largely from logging and land-clearing; it is partly unavoidable, and the more those industries are continued the more need there is for navigation.

I have to report that the Coquille River, from Coquille City to Myrtle Point, is worthy of improvement to the extent of snagging-work, and that for this work a survey is not necessary for preparing plans and estimates. From frequent travels on the Coquille River in connection with improving the mouth, and from late information, I am informed as to the condition of the river and the availability of means for work thereon. I estimate that $5,000, for a season's snagging-work between Coquille City and Myrtle Point and $500 for annual maintenance thereafter, will be required.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

T T 13.

PRELIMINARY EXAMINATION OF UMPQUA RIVER, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, January 31, 1887.

SIR: I have the honor to submit the following report of a preliminary examination of the Umpqua River, Oregon, as required by Department's orders for compliance with the river and harbor act of August 5, 1886:

The Umpqua River is in southwestern Oregon. The south and north forks rise in the Cascades Mountains, flow westerly, and after uniting, northward in a circuitous course to Elkton, where Elk Creek is received, and thence westerly to the sea. Its mouth is 22 miles north of the Coos Bay entrance, where an improvement is in progress, and nearly the same distance south of the Siuslaw River, where an examination has lately been made.

Roseburgh, a principal station of the Oregon and California Railroad, is on the south fork some 85 miles above Elkton. Scottsburgh, 20 miles below Elkton, is the head of navigation. Gardiner is a mill town near the mouth. Smith's River, on which good timber abounds, empties into the Umpqua above Gardiner.

Above Elkton the river is a little better than a mountain stream; there are a few good stretches of water near Roseburgh. From Elkton to Scottsburgh the river is a succession of pools and shallow rock rapids. Below Scottsburgh the Umpqua is a tidal water, obstructed by some bad reefs near Scottsburgh and two gravel bars below. The channel at the mouth of the river is regarded as a good entrance for coasters; lumber vessels, drawing 12 and 14 feet, ply between Gardiner and San Francisco.

It is not understood than any improvement of the mouth of the river is desired, but that an improvement from Gardiner to Elkton, and especially to Scottsburgh, is wanted. A survey or examination of the Umpqua River was required by the act of July 11, 1870. An examination was made that year from Roseburgh to Scottsburgh, which latter place

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was then, as now, the head of navigation. It was desired to have the river made an outlet for the agricultural and grazing region lying between the Coast and Cascade ranges, and of which Roseburgh is the center, and also for the Upper Rogue River Valley lying south of the Upper Umpqua. These regions were then only accessible by difficult wagon roads. Information was given that no obstructions existed below Scottsburgh.

From this examination, and from statements given by the pilot of a steamboat which had lately made an experimental trip to Roseburgh, an estimate of cost was submitted for practicable navigation to Roseburgh. The act of March 3, 1871, appropriated $22,500 for "the improvement of the Umpqua River, Oregon."

The work was commenced; all rocks reported troublesome were removed. The engineer in charge reported April, 1872, that the current was the only hindrance to navigation, and that a favorable season had passed without any serious attempt to navigate this part of the river. A recommendation was added that no further work be done. The unexpended balance, $4,685.89, was repaid into the Treasury. No further appropriation has been made.

The act of March 3, 1879, provided for a survey of the Umpqua River between Scottsburgh and its mouth.

The estimate of cost of improvement, recommended from this survey, is about $12,000, and was for affording a channel from Gardiner to Scottsburgh, desired for the 3-foot draught steamers then in use.

In June, 1885, I submitted a report on the proposed application of the unexpended balance upon the river below Scottsburgh. The examination and work on the upper part and survey of the lower river were explained in this report, and I added from information derived and my observation during several trips on the Lower Umpqua the following:

The river below Scottsburgh is a part of the tri-weekly mail route from Drain, on the Oregon and California road, to the lower river district, and by the coast north to the lower Siuslaw country and south to the Coos Bay region.

The wagon road from Drain to Scottsburgh is 35 miles, while the distance to navigable waters on the mail routes from the interior towards the coast, next north and south of the Umpqua route, is about 60 miles.

For four years at least the mail-boat on the Umpqua has been a small tug, necessarily drawing more than a stern-wheel steamboat, with which it was formerly expected to navigate the upper river.

The mail-tug draws 4 feet, carries passengers and express, and tows a scow for carrying freight. The tug is more economical than a stern-wheel boat, and adapted, which the latter would not be, for service near the mouth of the river where there are two mail landings. There is another steam-craft working on the lower river and generally used for towing logs. A bar-tug is stationed at Gardiner, which has, however, no special cause for going above.

The principal object for improving the river below Scottsburgh is to obviate delays to the mail-boat. The boat is now obliged to wait for the tide for crossing a few shoal places.

In my judgment the river below Scottsburgh is worthy of improvement.

In further compliance of orders, a project was submitted for applying the balance of funds. This project was for making a channel 3 feet deep by 50 feet wide at ordinary lowest water by rock removal at five reefs next below Scottsburgh. The work was subsequently undertaken and carried as far as the funds permitted; $1,000 are required to complete this project. I have to report that the river is worthy of such improvement, and that no survey is needed.

During the progress of the work the obstructive places in the channel below were examined. From these examinations and from the survey of 1879 I have estimated that $30,000 are required for contraction work

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at the two bars, removal of some bowlders and work additional to that of the present project on the Scottsburgh Reefs, in order to afford a needed 4-foot channel from Gardiner to Scottsburgh. Another survey is not required.

A coast and geodetic survey party has been at work on the Umpqua for the past few seasons. The topography has been executed from the mouth to 3 miles above Gardiner, including about 1 mile on Smith River, and the hydrography from and including the bar and approaches for the same distance up the river.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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APPENDIX U U.

IMPROVEMENT OF COLUMBIA AND WILLAMETTE RIVERS BELOW PORTLAND, OREGON, OF UPPER WILLAMETTE, UPPER COLUMBIA AND SNAKE AND COWLITZ RIVERS, OREGON AND WASHINGTON TERRITORY, AND OF LOWER CLEARWATER RIVER, IDAHO.

REPORT OF MAJOR WILLIAM A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1887, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Columbia and Lower Willamette Rivers, below Portland, Oregon.
2. Upper Willamette River, Oregon.
3. Upper Columbia and Snake Rivers, Oregon and Washington Territory.
4. Lower Clearwater River, Idaho.
5. Cowlitz River, Washington Territory.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, August 6, 1887.

SIR: I have the honor to submit herewith annual reports for the works of river improvements in my charge for the fiscal year ending June 30, 1887.

As the commerce in all the region in which these works lie centers in Portland, Oregon, to avoid repetition I will submit here the commercial statistics required by Congress, making reference thereto in the description of each work.

The rivers are in the collection districts of Willamette and Oregon. The ports of entry are Portland and Astoria, Oregon. The nearest light-houses and works of defense are at the mouth of the Columbia River.

Very respectfully, your obedient servant,

W. A. JONES,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

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COMMERCIAL STATISTICS.

Arrivals and clearances of vessels, and commerce, at Portland, Oregon, during the year ending June 30, 1887.

ARRIVALS AND CLEARANCES.

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Coastwise	183	236,884	118	165,664
Foreign ports:				
American vessels	3	3,798	27	26,419
Foreign vessels	51	52,577	110	116,637
Total	237	293,259	255	308,720

COMMERCE.

Exports	$5,135,025.00
Imports	819,477.00
Duties collected	205,873.33

Columbia River wheat fleets.

Years.	British.	American.	All others.	Total cleared.	Total tonnage.
1875–'76	48	9	2	59	60,556
1876–'77	53	9	7	69	57,157
1877–'78	62	10	4	76	74,429
1878–'79	49	13	1	63	65,301
1879–'80	67	8	6	81	73,359
1880–'81	71	15	3	89	79,038
1881–'82	102	16	5	123	117,281
1882–'83	55	19	6	80	82,601
1883–'84	74	18	2	94	98,687
1884–'85	91	19	4	114	113,639
1885–'86	126	11	4	141	153,806
1886–'87	121	10	1	132	142,397

Coal fleet arriving at Portland, Oregon, during the year ending June 30, 1887.

Months.	Domestic.		Foreign.		Totals.	
	Cargoes.	Tons.	Cargoes.	Tons.	Cargoes.	Tons.
July	1	2,510	4	1,791	5	4,301
August	1	900	8	4,640	9	5,540
September	3	3,100	3	1,544	6	4,644
October	2	3,290	9	8,799	11	12,089
November	3	4,225	3	2,280	6	6,505
December	3	3,426	7	5,220	10	8,646
January	2	3,582	.....	.....	2	3,582
February	1	1,596	.....	.....	1	1,596
March	1	649	9	9,771	10	10,420
April	1	1,838	4	5,111	5	6,949
May	2	2,375	2	3,626	4	6,001
June	2	2,670	1	2,067	3	4,737
Total	22	30,161	50	44,849	72	75,010

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Arrivals and clearances of vessels, and commerce, at Astoria, Oregon, during the year ending June 30, 1887.

ARRIVALS AND CLEARANCES.

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Coastwise	192	278,382	184	268,516
Foreign ports:				
American vessels	6	5,168	10	10,988
Foreign vessels	45	45,702	55	67,343
Total	243	329,252	249	346,841

COMMERCE.

Exports	$1,357,281.00
Imports	231,438.00
Duties collected	83,051.06

Statement of Cowlitz River traffic, furnished by Joseph Kellogg & Co., owners of the Cowlitz River steamers, for the year ending June 30, 1887.

Years.	General merchandise.	Hay.	Shingles.	Coal.	Lumber.	Logs.	Live stock.	Passengers.
	Tons.	*Tons.*	*Bunches.*	*Tons.*	*Feet, B. M.*			
1878	2,947	894	20,705	.....	776,120	(*)	3,020	8,439
1879	3,145	1,249	24,413	.....	1,196,281	(*)	5,725	9,240
1880	3,588	1,189	25,795	.....	1,257,500	(*)	4,178	10,472
1881	3,805	1,038	39,770	.....	1,358,640	(*)	5,502	11,155
1882†	10,285	(‡)	21,346	.....	1,658,000	13,000,000	5,364	11,632
1883	12,436	4,114	32,509	.....	1,498,083	(*)	5,586	21,227
1884	4,285	2,575	28,525	.....	850,094	12,000,000	3,312	12,000
1885	6,383	3,307	51,286	.....	1,802,517	(*)	4,317	12,835
1886	7,180	3,640	61,543	300	2,072,894	13,000,000	4,900	11,552
1887	7,898	4,110	67,594	.....	2,381,890	14,000,000	4,853	12,892

* Figures not given.
† Amounts for 1882 include Columbia River traffic between Portland and mouth of Cowlitz River.
‡ Included in general merchandise.

List of steamboats plying on Upper Willamette, Lower Willamette, and Columbia, Upper-Columbia, and Snake rivers, Oregon and Washington Territory.

Name.	Tonnage.	Name.	Tonnage.	Name.	Tonnage.
Upper Willamette River.		*Lower Willamette and Columbia rivers.*		Dolphin	60
				Wallaski	63
Salem	240	Governor Newell	134	Total	10,229
City of Salem	423	General Canby	44		
Calliope	93	Joseph Kellogg	272	*Middle and Upper Columbia River.*	
Champion	502	Lucea Mason	140		
Clara Parker	195	Lurline	338	Bonita	377
Fleetwood	68	Manzanilla	130	Dixie Thompson	297
Latona	75	Multnomah	278	Hassalo	350
Little Annie	72	R. R. Thompson	912	Harvest Queen	697
Mountaineer	47	S. G. Reed	607	Fred Billings	383
Western Queen	75	Telephone	334	Kootenai	268
Three Sisters	296	Toledo	207	Total	2,372
Wonder	225	Traveler	145		
Alliance	140	Wide West	929	*Snake River.*	
Pioneer	80	Tacoma	1,312		
Bonanza	468	Alice	334	D. S. Baker	566
Occident	430	E. N. Cook	299	Almota	395
Orient	430	Ocklahama	394	Mountain Queen	511
Willamette Chief	524	Beda	269	John Gates	550
S. F. Church	394	Walla Walla	1,239	Spokane	250
Isabel	200	Alaskan	1,259	Annie Faxon	566
N. J. Bentley	401	Fannie	276	Total	2,837
P. W. W	59	Dewdrop	80		
		Montesano	87		
Total	5,437	General Miles	68	Grand total	20,866
		Margey	98		

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Statement of exports from Portland, Oregon, during the year ending June 30, 1887.

Articles.	Quantity.	Value.
Foreign.		
Wheat ..... bush..	5, 202, 760	$3, 979, 669
Flour ..... bbls..	400, 545	1, 458, 468
Salmon ..... lbs..	9, 656, 300	987, 422
Lumber ..... feet..	11, 015, 000	119, 488
Other articles	.....	157, 635
Total value	.....	6, 702, 682
Domestic.		
Wheat ..... bush..	1, 169, 820	970, 886
Flour ..... bbls..	115, 371	525, 772
Salmon ..... lbs..	22, 646, 500	2, 038, 185
Wool ..... do....	12, 374, 810	2, 230, 762
Woolens ..... cases..	783	156, 850
Millstuffs ..... sacks..	153, 200	90, 725
Flax-seed ..... do....	64, 968	196, 515
Hides ..... lbs..	2, 839, 513	216, 800
Hops ..... do....	5, 664, 349	1, 076, 795
Barrel-stock ..... pkgs..	12, 639	25, 180
Potatoes ..... bush..	182, 860	120, 475
Oats ..... do....	372, 945	171, 115
Barley ..... bush..	35, 000	$16, 025
Leather ..... lbs..	85, 824	14, 590
Tallow ..... pkgs..	1, 271	8, 005
Provisions ..... do....	13, 370	121, 585
Iron ..... tons..	945	21, 620
Lumber ..... feet..	31, 982, 000	348, 576
Lathe	9, 293, 000	18, 310
Green fruit ..... boxes..	112, 771	81, 675
Dried fruit ..... pkgs..	8, 178	66, 930
Copper ore ..... sacks..	19, 344	46, 550
Onions ..... bush..	19, 416	12, 780
Furs ..... lbs..	59, 997	81, 367
Seal skins ..... do....	29, 594	23, 475
Oil ..... bbls..	1, 188	10, 250
Teasels ..... cases..	22	22, 000
Stoves ..... No..	2, 184	38, 220
Merchandise, unspecified ..... lbs..	5, 990, 000	132, 900
Other articles	.....	1, 743. 923
Total value	.....	10, 728, 951
Aggregate		17, 431, 633

Receipts of produce at Portland, Oregon, during the year ending June 30, 1887.

	* Valley.	† Eastern.	Total.
Wheat ..... pounds..	130, 479, 600	297, 912, 500	428, 392, 100
Flour ..... do....	41, 148, 400	22, 872, 400	64, 020, 800
Oats ..... do....	21, 088, 100	100, 000	21, 188, 100
Barley ..... do....	1, 313, 500	2, 882, 700	4, 196, 200
Bran ..... do....	2, 275, 500	277, 600	2, 553, 100
Millstuff ..... do....	8, 361, 800	1, 252, 600	9, 614, 400
Potatoes ..... bushels..	72, 854	.....	72, 854
Wool ..... pounds..	1, 686, 170	10, 120, 149	11, 806, 319
Hides ..... do....	780, 067	2, 004, 491	2, 784, 558
Butter ..... packages..	2, 745	.....	2, 745
Eggs ..... cases..	21, 311	56	21, 367
Fruit ..... boxes..	134, 860	2, 014	136, 874
Lime ..... barrels..	19, 764	.....	19, 764
Flaxseed ..... sacks..	15	64, 455	64, 470
Hops ..... pounds..	5, 811, 163	15, 337	5, 826, 500

* Willamette Valley. † Country tributary to Upper Columbia and Snake rivers.

Statement of traffic through the Willamette locks during the year ending June 30, 1887.

Description.	Quantity.
Freight down ..... pounds..	52, 398, 000
Freight up ..... do....	5, 455, 500
Lumber down ..... feet, B. M..	430, 956
Passengers down ..... number..	3, 776
Passengers up ..... do....	2, 825

The locks were closed for repairs from July 15 to September 1, 1886.

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U U 1.

IMPROVEMENT OF COLUMBIA AND LOWER WILLAMETTE RIVERS, BELOW PORTLAND, OREGON.

This project covers the Columbia River from its mouth to the Willamette, and this river as far up as the city of Portland, Oregon, the whole distance being 100 miles. It provides for a ship-channel of 20 feet at low water, to be effected by contraction works and shore protection at four bars between Portland and Columbia City; by temporary improvement; by dredging at those bars during the construction of the permanent works; by temporary improvement at three bars below Columbia City, and by snagging operations. The mean tide at Portland or a low-river stage is about 2 feet; at Astoria it is 7½ feet. This project now keeps the river below Portland about equal in navigability with the Columbia River Bar, and enables the average ships of the world to come inland 100 miles toward the place where the export products are raised. As the deep-water sea-going ship is the cheapest known means of transportation, it at once becomes evident what an important factor this river improvement must be in the prosperity of the region whose products find an outlet by means of it. In fact, commercial statistics submitted reveal an extraordinary preponderance of foreign exports over imports which is very rapidly contributing to the wealth and prosperity of the country. Herein lies the secret of the location of Portland. She is placed where the deep-water ship, having broken through the coast line, has gone 100 miles inland toward certain great commercial commodities.

The appropriation of $75,000 was by the act divided as follows:

Portland Harbor	$5,000
River works	49,000
Snagboat for service on Lower and Upper Willamette and tributaries	21,000

PROPELLER DREDGING AT ST. HELEN'S BAR.

Work began early in August upon the upper or dredge channel at St. Helen's Bar. This channel having become closed during the summer flood so as to prevent the passage of deep-water ships, which form a large part of the commerce of Portland, Oregon, special authority for opening it by propeller dredging was obtained by telegraph August 18, as soon as possible after the appropriation became available. The towboat *Cascades* was placed in thorough repair for service as tender, the steamship *Umatilla* was hired, and men and materials were assembled with all possible dispatch.

August 23.—The *Cascades* of the Columbia dropped down to St. Helen's Bar and marked out the range of the bar by sinking piles by means of a hydraulic jet. This was done to provide against the shore range being obscured by the fog and smoke prevalent during the latter part of the summer.

August 25.—The *Umatilla* and *Cascades* dropped down to the bar. The steamship left Portland 11.30 a. m.; arrived at the bar at 2.20 p. m. After some minor delays attendant upon handling so large a ship in a shallow channel without headway, the *Umatilla* was all anchored and ready for work at 9.15 a. m. the next morning (26th).

The following description of the *Umatilla* is introduced here to give a better idea of the magnitude of the operations:

OREGON RAILWAY AND NAVIGATION COMPANY'S STEAMSHIP UMATILLA.

Built at Chester, Pa., 1881; cost, $400,000; length over all, 330 feet; beam, 40.08 feet; draught loaded, 23.4; gross tonnage, 2,131.49; official record, 1,335.62; six

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cylindrical boilers 11$\frac{7}{12}$ feet long by 11½ feet diameter; working steam pressure, 80 pounds.

Engines.—High-pressure: Diameter of cylinder, 40 inches; length of stroke, 54 inches; boiler pressure, 75 pounds; receiver, 10 pounds. Low-pressure: Diameter of cylinder, 74 inches; length of stroke, 54 inches; vacuum, 26 inches.

Crank-shaft, 14 inches diameter, 150 feet long from cranks. Indicated power developed while sluicing St. Helen's Bar, 1,116 horse-power.

Operations were continued with such short interruptions as are incident to the commencement of large work until 4 p. m. on the 30th, when, the channel being completely opened, she cast off her sluicing hawsers, hove anchor, and was turned over to her owners at 7.15 p. m. Everything had been previously arranged to have no detention of the steamship after the channel was cut. The channel thus cut in five days of actual work, and six days including detention en route, was 1,500 feet long and 200 feet wide.

Over this width 150 feet was cut to a depth of 20 feet at low water. The river stage was 2 feet above low water. One or two small lumps were left, through the willfulness of the sailors on watch. They were much opposed to such kind of work for a ship, and in their anxiety to get through with it rapidly when told to take in 30 feet on the hawsers in fleeting, persistently took in 50 and 60 feet until I stood guard over the measuring. Fortunately, this was stopped before going far.

The expenses of this performance were as follows:

Steamship, six days, at $375	$2,250
Detention in port prior to going to work. (This item can be avoided)	360
Steamboat tender, eight days, at $40	320
Materials and incidentals, wear and tear, etc., about	270
	3,200

As there was no time to take soundings before work began, the quantity of material moved cannot be stated. The performance, however, may be briefly epitomized by stating that in five days of steamship work, at a cost of $3,200, a straight channel was cut 1,500 feet long, 200 feet wide, with a depth of 22 feet over about 150 feet of said width.

The possibilities of this method may be inferred from the fact that while dredging the propeller worked generally against a breast of sand 15 feet high with 7 feet of water over the crest, and progressed when the crew were kept well in hand at the rate of 30 feet in thirty-seven minutes, four minutes of which was taken for fleeting, or taking in hawsers and dropping down into the finished cut.

As this was my first attempt at this kind of work, and the whole thing was finished so soon, there was no time to mature means for pushing the method toward its limits. As the time for the ship is the main item of expense, none should be lost. She should work night and day continuously. The ship had a sea-crew organized for such work.

The method has the merit of economy and extreme rapidity. The great bulk of the material moved is laid along the crest of the cut on the port hand. Notwithstanding the great current produced, the bulk of the material does not move far. The great power is necessary for the preservation of a head of water above the ridge piled up in the rear in the cut.

RÉSUMÉ OF THE STEAM PERFORMANCE OF THE STEAMSHIP UMATILLA WHILE DREDGING AT ST HELEN'S BAR, COLUMBIA RIVER.

August 25, 1886, 11.30 *a. m.*—Ship left Portland; arrived at St. Helen's Bar 2.20 p. m. Towboat *Cascades* at work laying out hawsers and anchors. The starboard anchors were run out and ship moved into position. Let go main anchor.

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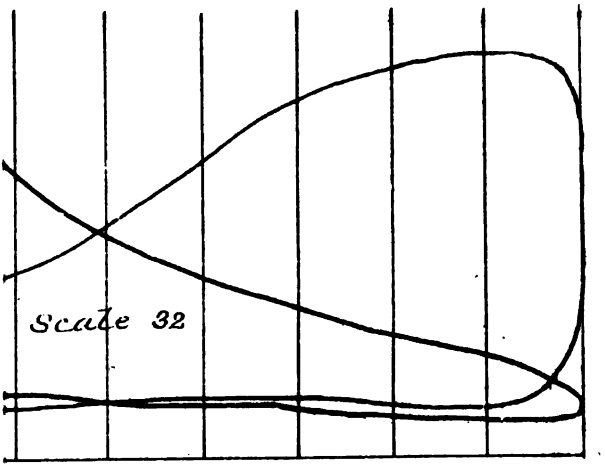

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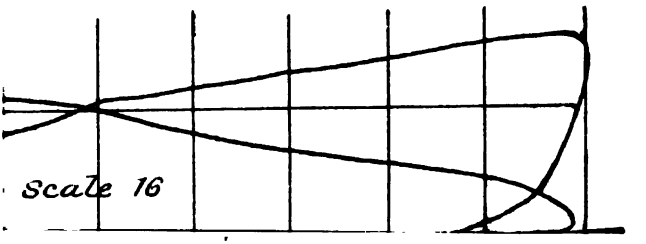

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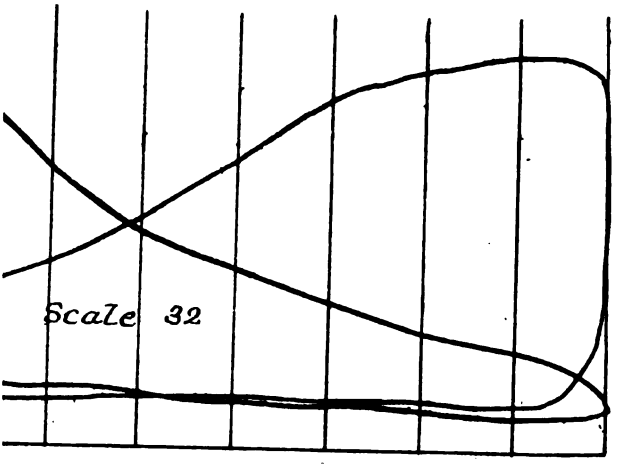

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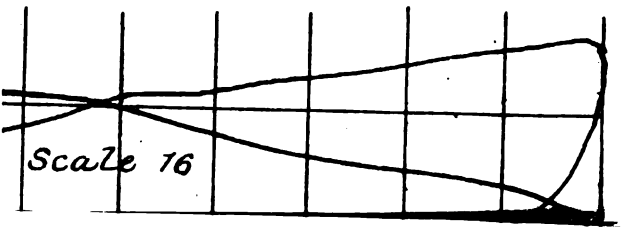

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August 26, 6 *a. m.*—Commenced running out the port anchors when the ship swung across the channel out of place. Wind and tide running. The towboat *Cascades* was placed bow on against her and pushed her gradually back into place against the current. The propeller could not be used, as the lines would have fouled in it.

Began sluicing 9.15 a. m; stopped 5.30 p. m. Engines run 5 hours and 43 minutes. Whole number of revolutions, 15,740; average per minute, 45; average when in full headway, 55. Steam pressure, 70 pounds; number of stops, 15. Coal burned, 34 tons.

The stops were for fleeting and were much too long. By drilling the crew the time was afterward reduced to four minutes.

August 27.—Commenced work at 7 a. m., running without detention except for fleeting until 12.50 p. m., when the starboard anchors were moved down by the tender. Work then continued until 6.20 p. m.

Commenced 7 a. m; stopped 6.20 p. m. Engines run 8 hours and 36 minutes. Number of revolutions, 24,340; average per minute, 47. Steam pressure, 75 pounds; number of stops, 18. Coal burned, 32 tons.

The engineer's crew being incomplete, work was necessarily suspended fifteen minutes for dinner.

August 28.—Moved main anchor. Hoisting engines hauled in chain cable with much difficulty, during which time the engines were moved forward and back at very short runs at from one to two minutes.

Began sluicing 7.40 a. m.; stopped 6.15 p. m. Engines run 8 hours and 31 minutes. Revolutions, 25,920; average, 48. Steam pressure, 75 pounds; number of stops, 16. Coal burned, 30 tons.

August 29.—Work commenced as usual and progressed favorably until 3.52 p. m., when, under the influence of rising tide and cross-currents, the ship drifted out of place and had to be pulled back by the tender. At 6.15 work was stopped, and there the head anchor was moved down by the tender.

Began sluicing 7 a. m.; stopped 6.15 p. m. Engines run 9 hours and 30 minutes. Revolutions, 25,440; average per minute, 44. Steam pressure, 75 pounds; stops, 28. Coal burned, 35 tons.

During the time the ship was against the bank the engines were reversed, and worked sometimes not to exceed two minutes either way.

August 30.—At 7 a. m. the tender moved both breast-anchors, and the lines were taken up equally on either hand. At 12.30 p. m. a loss of 32 minutes occurred through the firemen striking for fresh meat for dinner.

4 p. m.—The sluicing was announced finished. The hawsers for the breast-anchors were cast off to be picked up by the tender, anchor was weighed, and the *Umatilla* sailed through the cut and up to Portland, where she arrived at 7.15 p. m. The tender picked up the anchors and came up later.

Began sluicing 7.50 a. m.; stopped 4 p. m. Engines run 6 hours and 16 minutes. Revolutions, 17,913; average per minute, 47. Steam pressure, 75 pounds; stops, 20. Coal burned, 30 tons.

Totals.—Whole running time of engines, 38 hours and 36 minutes. Whole stopping time of engines, 11 hours and 11 minutes. Steam, 75 pounds. Average revolutions per minute, 46; coal burned, 171 tons; coal per hour, 3.4 tons.

Indicator cards were taken under my personal direction when the engines were doing their normal work, from which it appears that they developed ordinarily about 1,100 horse-power. Tracings from the cards are herewith.

The work was conducted by Hon. John Gates, mayor of Portland and chief engineer of the river and marine division of the Oregon

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Railway and Navigation Company, to whose skill and judgment the success of the operations were mainly due.

RIVER WORK.

Surveys.—Early in September the floating plant, which was in very bad condition from long disuse, was assembled and extensive repairs put upon it preparatory to commencing operations. As the work was turned over to me with no funds I had no means of making a systematic examination and estimate, and the great cost of these repairs has borne heavily upon the season's work. Every boat and scow required considerable repairs.

A survey party was at once placed on the river to examine the bars involved in the project for the season's work. A quarterboat scow was used by this party, which moved down the river from bar to bar, with wind and current, and was afterwards placed as a quarterboat at Saint Helen. These surveys were completed in November and developed the fact that no dredging would be necessary upon the bars below Portland. Surveys were made at the following points, and charts have been completed of them:

Willamette River: Ross Island Bar, Swan Island Bar, Post-office Bar, bar at the mouth.

Columbia River: St. Helen's Bar, Martin's Island Bar, Walker's Island Bar.

The ruling depth at all these points was found to be greater than at any previous low-water stage since systematic improvement of the bars began, although the water fell lower than at any time within the last ten years, the gauge marking 1 and 2 feet below zero for several weeks in October and November. The channels were fairly well maintained throughout the whole low-water season.

Dike at St. Helen's Bar.—The survey showed that the river was cutting a channel along the dike at a very rapid pace; also, that near the shore end of the dike where it crosses an old channel it had been seriously attacked by undermining. At this point the main current of the river comes upon the dike nearly at right angles. It is, therefore, the vital point of the whole structure. The repairs at this point and additional work for holding the bottom above and below were very extensive. Elsewhere it was in good condition and has withstood the attacks of drift and ice with perfect success. Great quantities of drift have lodged in front of it, become water-logged and sunk, and filled nearly solid with sand up to about low-water mark. Immediately in rear the deposition of sand has been extensive, so that as the dike now stands it is practically solid up to low water for most of its length. Repair work began October 10. Broken piles, waling, and braces were pulled out and new ones put in; a row of piles in front of and parallel with the axis of the dike was driven to cover disrupted sections, braced strongly to it, and waled; the mat work was built up to low-water mark and heavily ballasted with stone, and the bottom above and below extensively covered with mattress and riprap stone.

Early in November an additional survey was made of the bar in order to more fully develop its shape and indicate the changes which might be expected from the extension of the dike. In November the repairs were all completed and 1,112 feet of new work began and nearly completed.

By this time a study of the facts and conditions developed led me to believe that a further extension of the dike would be unwise until after

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the tremendous cutting produced by it had been allowed to approach its maximum effect. The probabilities were strong that the desired channel across the bar would be produced without any further expenditure or interference with the regimen of the river. The dike as now constructed reduces the section to an extent which at other points in the neighborhood is attended with excessive depths. Subsequent surveys made in February and April all strengthened this position, and a channel may reasonably be expected soon. Upon the completion of the new portion of the dike the force was reduced to a basis for repair work and most of the plant called in.

The surveys in February and April show that in the two months between them the 24-foot curve advanced 400 feet. The 20-foot curve (the depth called for in the project) advanced 800 feet, attaining a width opposite the end of the dike of 600 feet and of 400 feet at its extremity. This reduces the distance between the 20-feet curves above and below the bar to 400 feet. Across this reach and for a considerable distance above the whole crest of the bar (with minor exceptions) has been planed down to a minimum depth of 14 feet below low water and there is a good 16-foot channel across it.

REPAIRS OF CONSTRUCTIONS.

In December the repair party was placed at the head of Willamette Slough, where an extensive injury to the bank at the east end of the dam built in 1879–'80, caused by a recent flood in the Willamette, was repaired; also the dams across the head of Pearcy's Slough, where settlement of the mattress work had taken place, were built up. Other minor repairs of the constructions about the mouth of the Willamette River were made, when, on the 31st of January, 1887, the party was discharged and the plant laid up. Some minor repairs were also made in February. The failure of the river and harbor bill stopped all further operations, it being necessary to reserve all balance of funds for care and maintenance of plant and office for a probable period of a year and a half.

PORTLAND HARBOR.

In the appropriation bill for this year, under the head of improving Lower Columbia and Willamette rivers, there was an item of $5,000 for Portland Harbor. This was intended, as shown by the correspondence preceding the act, to apply to the improvement of the bar or bars in the vicinity of Ross Island. Previous reference has been made to the survey of this bar in October. This was merely preliminary to enable me to better direct the surveys to be made after those upon the river bars had been completed. November 16, a survey party, under the directions of Mr. S. W. Walker, commenced a systematic survey of the river in the vicinity of Ross Island. The high and low water slopes and the low-water discharge had been formerly determined by R. A. Habersham, under the direction of Col. G. L. Gillespie, Corps of Engineers. Borings had been made by the party working there in October. Early in December this survey was completed. It included a determination of the low-water discharge of the Willamette River at Oregon City. At this point, with the water standing at 1.7 above zero, the discharge was found to be 17,866 cubic feet per second. Loaded rod floats were used and the river divided into longitudinal sections for determining the mean velocity. The above discharge should be increased by that of the Clackamas River, about 300 cubic feet per second,

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and reduced by the water pumped for the city of Portland. But these items are within the limits of possible error in determining the mean velocity by the method adopted, and hence the approximate discharge at Ross Island may be stated at 18,000 cubic feet per second at the stage of the measurements. Further borings were taken in May, 1887.

This survey develops a long cobble-stone bar opposite the upper end of Ross Isand, in the west channel, with a low-water depth on it of 8 feet. Also a considerable bar opposite Sellwood, with 11 feet at same stage. To make a channel here with 20 feet at low water will require extensive dredging operations in cobble-stone and probably bed-rock. The sum of $5,000 appropriated is not sufficient to commence work, and it will be necessary to hold the balance after deducting the cost of surveys, etc., subject to further appropriation by Congress.

SNAGBOAT.

In the act of August 5, 1886, making appropriation for improving the Lower Columbia and Willamette rivers, there is an item of $21,000 for the construction of a snagboat to operate upon the Columbia and Willamette rivers and tributaries. Pending the development of plans for this boat, I had the snagboat *Corvallis* repaired for the season's work, as she could not possibly be finished in time for the same. Considerable delay having been met with in preparing these plans and in the correspondence preliminary to advertising for the contract, the failure of the river and harbor bill became known before the arrangements for advertising were completed. This brought about a state of affairs which rendered the immediate construction of the boat inadvisable. As there can be no use for her until after another appropriation, it will be better not to have her completed and delivered much before that time, as she would only involve more expense for care and maintenance. Contracts will be made shortly involving delivery next June or July.

SNAGS.

From time to time as snags have appeared they have been removed by the towboat *Cascades* or the propeller *Lincoln*.

MARTIN'S ISLAND BAR.

The following plan for improving Martin's Island Bar, Columbia River, has been submitted and approved, with minor modifications:

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, January 26, 1887.

SIR: I have the honor to submit the following project for closing the sloughs that flank Martin's Island Bar on the Columbia River below the mouth of the Willamette:

The main river at this point has a sectional area of 97,330 square feet at low water and 171,250 square feet at bank-overflow stage. Velocities are approximately about 2.5 feet and 7 feet per second at those stages. The bar lies along the front of Martin's Island. It has an ample depth at low-water stages, except upon a few scattered lumps which lie directly in the channel. It is a high-water bar, deposition taking place at high stages only, when the wet section is too great to maintain the velocity with which the water arrives upon it. The lumps in the channel and the good water around them are, in my judgment, an indication that the velocities at high water are nearly sufficient to maintain the channel, and it is probable that the deflection of a portion of the high-water discharge of the sloughs through it will be sufficient to enable the maintenance of a channel.

The difference between high and low water at this point is 22 feet, approximately.

The extreme rise and fall of the tide is 3.5 feet, approximately.

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The low-water reference plane has not been fixed with precision, but is average low water as determined by the U. S. Coast Survey.

I am not prepared to make any precise statements as to the discharge at high and low water stages through either main river or the sloughs, since no current measurements have been taken there, and I have not had time to make them. It is pretty evident, however, that a very large volume of water will be added to the discharge through the main channel.

It will appear from the map that this would throw more water into Deer Island Slough, and I therefore submit a plan for closing it. As the bank in front of Martin's Island is being eroded, it will doubtless cut away considerably faster under the new conditions imposed upon the channel, and hence I propose to revet it, but not until after it has been watched through a high-water season under these new conditions.

In designing the structures I have followed the successful practice on the Mississippi River, with such modifications as are demanded by the change of conditions.

I propose to close Martin's and Burke's sloughs with permeable dams of wattled piles, well secured at the ends of either upon the banks, or a close forest growth of cottonwoods and underbrush.

These dams will be of piles laid with 5-feet openings, wattled with willow brush and strongly capped with double waling timbers, 6 by 12 inches, bolted in the usual manner.

The crest of the dams will be held 16 feet above low water; this with a view of reducing the slough discharge at high-water stages. It is also proposed to revet the bed and banks on the river line of the dams with thin brush-mattress, ballasted as shown in the drawings, and extending 30 feet above and 30 feet below. The dams will be braced to a row of short piles placed in rear of the line, said braces to be of 6 inch by 12 inch timbers, bolted to main piles and held to brace piles at the surface of the ground by bent shackles, as shown in the drawings.

This mode of fastening braces has been executed by me with perfect success at Saint Helen's. It is simple, cheap, and effective. Braces will be laid at intervals of 15 feet.

On shore the piles will be sunk as posts, and careful measures will be taken to secure the ground around the extremities of the dams. It is anticipated that these dams will rapidly fill up the sloughs just below them to above low water, when a growth of grass, willows, and cotton-wood will be started to make the closure permanent.

At Deer Island it is proposed to lay up from material immediately at hand a fascine dam well tied through from top to bottom and weighted with rock, or gravel and sand in bags, all as shown in the diagrams submitted. Height above low water to be 6 feet. This slough is of the same width as Burke's, but being bare at low water will not require a dam more than 6 feet.

The site not being accessible to barges except at high-water stages, when work is more expensive and difficult, explains the recourse to a fascine dam. When the river reaches a sufficient stage, stone barges can come in and complete the ballasting with riprap. It is expected that willows will grow up from this dam and make it permanent.

DAM AT MARTIN'S SLOUGH.

Length	feet..	700
Mean depth at low water	do...	10
Average height of dam	do...	26
Average low-water section of slough, say	square feet..	7,000
Average section at top of dam, say	do...	9,500
Low-water velocity per second, about	feet..	1.5
High-water velocity per second, about	do...	5

ESTIMATE.

Foundation mattress, 60 by 700 feet, 5,000 square yards, at 30 cents	$1,500
Waling and bracing, 18 by 6 by 12-inch timber, at $8	144
Piles, 7,000 linear feet, at 5 cents	350
Bolts and spikes, 1,000 pounds, at 8 cents	80
Labor, including pile-driving	875
Rock, 400 cubic yards, at $1	400
Contingencies and superintendence, 15 per cent	500
Total	3,849

Say $5.50 per linear foot.

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DAM AT BURKE'S SLOUGH.

(For site see map.)

Length	feet..	250
Mean depth at low water	do...	9
Average low-water section, 250 by 9	square feet..	2,850
Average section at top of dam, say	do...	6,250
Low-water velocity per second, about	foot..	1
High-water velocity per second, about	feet..	3

ESTIMATE.

250 feet of dam, at $5.50	$1,375

DAM AT DEER ISLAND SLOUGH.

(For site see map.)

Length	feet..	300

ESTIMATE.

400 cords fascines, at $1.50	$600.00
10 coils bale rope, at $6	60.00
Labor	500.00
1,000 sand bags, at 5 cents	50.00
Superintendence and contingencies, 15 per cent	181.50
Total	1,391.50

SUMMARY.

Martin's Slough	$3,849.00
Burke's Slough	1,375.00
Deer Island Slough	1,391.50
Total	6,616.50

The following maps are submitted:
Map of Columbia River at Martin's Island.
Map of Martin's Slough.
Map of Burke's Slough.
Map of Deer Island Slough.
Sheet of diagrams.
Duplicates for supervising engineer.

Very respectfully, your obedient servant,

W. A. JONES,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.
(Through Col. G. H. Mendell, Supervising Engineer.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., March 1, 1887.

Respectfully forwarded, approved with modifications stated in accompanying letter of this date.

G. H. MENDELL,
Colonel, Corps of Engineers.

LETTER OF COLONEL GEORGE H. MENDELL, CORPS OF ENGINEERS, SUPERVISING ENGINEER.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., March 1, 1887.

SIR: The low-water area of section of the Columbia River at Martin's Island is stated in Major Jones's project as nearly 100,000 square feet. The aggregate area of cross-section of the three sloughs is, at the points of occupation, about 10,000 square feet. Closure of these sloughs will reduce the low-water river section by 9 or 10 per cent.

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and increase the low-water complement by a percentage somewhat less. The effect of closure is certainly beneficial in tendency, and it may develop an improvement in the channel which will satisfy the needs of navigation and dispense with the necessity of further construction or of further dredging, which are now required periodically in the low stage of the river. It is thought, however, that the benefit of closure will be found to be more marked in the lower stages of water than in the higher stages.

I am not able to agree entirely with Major Jones's views as to the desirability, and particularly as to the practicability, of controlling the river in its higher stages by the proposed construction.

It appears to me to be unnecessary to carry the construction higher than 8 or 10 feet above low water. The maximum height of construction, as proposed in the project for Martin's Slough, is 34 feet, which, in my judgment, is too great a height for the construction indicated. If this height were reduced 8 or 10 feet, and a double waling of about 8 inches placed near low water, let into the piles and bolted every 3 or 4 feet with 1½-inch bolts, with brace-piles every 4 or 5 feet or less in the deep water, and not more than 10 feet apart at any point, the increase of strength thereby conferred would not be more than is likely to be needed. Indeed, I am not entirely persuaded as to the advisability of light permeable dams in positions of permanent occupation on the Columbia River. I would prefer a strong double-piled dam, of thickness from 4 to 10 feet, in some proportion to the depth of water, filled with brush and stone.

The opinions of the local officers are, however, in favor of constructions such as have been used on the Mississippi River, and I do not therefore insist upon my own opinion at present, and am content to recommend for the present the constructions proposed, adding such elements of strength as appear to me to be indispensable, as hereinbefore stated. The positions were recently observed during a visit to the site. There is now navigation on the slough below, and it is understood that there will be no opposition from local interests if the dams are placed at the head of the sloughs.

Perhaps it will be clearer to state that my distrust of light works is due to my opinions in regard to the extent of repairs likely to be needed after freshets, or in seasons when there is considerable ice in the river, and also to the difference in amount and character of sediment carried in freshets and at other stages in the Mississippi and Columbia rivers. The local officer must, however, be presumed to know local conditions better than myself, who have not all his advantages.

With the modifications herein suggested the project is approved.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 14, 1887.

Respectfully returned. The project is approved, subject to such modification as in the judgment of Major Jones may appear necessary to meet the views of the supervising engineer in the within letter of transmittal to this office of March 1, and on the condition that, as stated in Major Jones's letter to this office of December 2, there are sufficient funds available for the work.

After such record as may be necessary has been made, these papers will be returned to this office by Major Jones.

By command of Brigadier General Duane.

JOHN G. PARKE,
Colonel of Engineers, Brt. Maj. Gen., U. S. A.

[Third indorsement.]

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, April 4, 1887.

Respectfully returned to the Chief of Engineers. In my judgment the views of the supervising engineer may be met by introducing the double waling at or near the low-water level, and bracing alternately every ten feet from this and the cap waling.

It should be observed that the proposition for a light permeable dam depends entirely upon forcing deposition to such a height above low water as to enable the occupation of the ground in a permanent way by a growth of trees and plants. To do this on the Columbia River it is necessary to occupy the high-water section, since it is only during high-water stages that the river carries silt in sufficient quantity.

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At low and average stages the waters are clear, with the characteristic blue appearance of clear water.

Between this proposition and that for occupying the low-water section with structures of wood there is no middle ground. I am quite disposed, however, to defer to the judgment of the supervising engineer, and hence, in accordance with the instructions contained in the first indorsement, will build dams of two rows of piles as suggested by him, and terminating about at the low-water level, unless otherwise ordered.

The balance of funds in hand will not justify the commencement of this work before another appropriation.

W. A. JONES,
Major of Engineers.

It is proposed with the sum recommended for appropriation to complete the project for permanent works over the whole tidal section; to complete the works proposed at Martin's Island; to complete the project for Portland Harbor; to do all necessary dredging for temporary improvement; to make all necessary repairs for the maintenance of construction and plant.

APPROPRIATIONS.

Act June 23, 1866, Lower Willamette	$15,000	
Act March 2, 1867	30,000	
Act July 25, 1868 (allotted)	21,000	
Act April 10, 1869 (allotted)	13,365	
Act July 11, 1870	31,000	
Act June 10, 1872	50,000	
		$160,365
Act March 3, 1873, Lower Willamette and Columbia, from Portland to the sea	20,000	
Act June 23, 1874	20,000	
Act March 3, 1875	20,000	
Act August 14, 1876	20,000	
Act June 18, 1878	30,000	
Act March 3, 1879	45,000	
		155,000
Act June 14, 1880, Lower Willamette and Columbia, from Portland, Oregon, to the sea, including bar at the mouth of the Columbia	45,000	
Act March 3, 1881	45,000	
Act August 2, 1882	100,000	
		190,000
Act July 5, 1884, Columbia and Lower Willamette rivers, below Portland, Oregon		100,000
Act August 5, 1886		75,000
Total		680,365

For commercial statistics, see letter of transmittal.

Money statement.

July 1, 1886, amount available	$0.51
Amount appropriated by act approved August 5, 1886	75,000.00
	75,000.51
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	50,396.46
July 1, 1887, amount available	24,604.05

Amount (estimated) required for completion of existing project	400,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	400,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

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U U 2.

IMPROVEMENT OF UPPER WILLAMETTE RIVER, OREGON.

The object of the improvement is to secure light-draught navigation as far up as Eugene City, Oregon, inclusive of 12 miles of tributaries, an aggregate distance of 184 miles.

The plan consists of snagging, bar scraping, wing-dam construction, and rock-blasting. The present project was adopted in 1878. Estimated cost was $80,000, exclusive of about $12,000 per year for maintenance. The total amount appropriated to date for this project, $84,000. Amount expended thereon to date, $81,089.27.

Operations were commenced about the middle of September, 1886, by putting the snag-boat *Corvallis* in thorough repair. The following work was done upon her, at a cost of $900, and she was placed in the field September 27:

Cavallis refitted, new bitts, new braces on sheer legs, ten new deck beams forward, six new deck beams aft, six new bucket planks, caulked all round, six new wheel buckets, 8-foot pieces of oak on each side, strengthened cylinder-bearing for shaft, holes repaired on each side of gunwale, one piston-ring replaced, new covering-board forward, feed-pipe repaired.

Owing to the lateness of the season and the extremely low stage of the river impeding the progress of the boat, the winter freshet of the Willamette came on before the work contemplated was completed, and she was laid up with a view of renewing operations in the spring.

Unfortunately the failure of the river and harbor bill in this interval rendered it necessary to suspend all further operations and use the balance of the appropriation in the care and maintenance of plant and constructions.

The following work was done:

Month.	Feet of wing-dams constructed.	Number of snags removed.	Kind.
October	100	164	Cottonwood, fir, ash, and willow.
November		165	
December		67	
		39.6	

An examination of the river at Corvallis, Oregon, in compliance with Senate resolution calling for same, with a view to determine project for preventing a cut-off at that point was made, and a project completed and presented, as follows:

RESOLUTION.

IN THE SENATE OF THE UNITED STATES,
December 13, 1886.

Whereas, It is alleged that the Willamette River, near the city of Corvallis, is about to cut a new channel by which said city will be left at a considerable distance from the river, the navigation of the river destroyed or greatly impaired, and much damage done to adjacent lands:

Resolved, That the Secretary of War be, and he is hereby, directed to cause an examination of said river at said point to be made, and report to the Senate at the earliest practicable day, what works, if any, are necessary to prevent such threatened change in the channel of the river, and an estimate of the cost thereof.

ANSON G. MCCOOK,
Secretary.

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LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY,
Washington, D. C., December 14, 1886.

SIR: The inclosed copy of a resolution of the Senate of the United States, dated December 13, 1886, is transmitted for your information and for report.

You will proceed at the earliest practicable period to make such examination of the locality in question as will enable you to comply with the requirements of the resolution and submit an estimate of the cost of such work as you may deem it advisable to propose.

The expenses of the examination will be defrayed from the appropriation for improving the Upper Willamette River above Portland, Oregon.

By command of Brigadier-General Duane.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Colonel of Engineers, Brt. Maj. Gen., U. S. A.

Maj. W. A. JONES,
Corps of Engineers, Portland, Oregon.

REPORT OF MAJOR W. A. JONES ON THREATENED CUT-OFF.

JANUARY 8, 1887.

SIR: I have the honor to submit, in compliance with instructions contained in Department letter of December 14, 1886, the following report upon the threatened cut-off in the Willamette River, at Corvallis, Oregon:

REPORT.

The city of Corvallis is situated on the lower arm of a deep S bend in the Willamette River. In the first, or upper concave of this bend, the river has cut in deeply and now threatens a cut-off at the point shown on the sketch herewith.

The city stands on a low bluff of hard alluvium on the western border of the wide bottom of soft material through which the river runs. Through this bottom the stream, subject to sudden and extremely violent floods, meanders through channels and sloughs that are continually shifting over considerable distances from side to side.

The winter floods usually cover this alluvial bottom several feet deep. Below the concave bend, where the cut-off is threatened, the river floods usually cover the whole bottom down to the river below the city to a depth of from 4 to 8 feet. The flood velocities probably reach as high as 7 miles per hour. As soon as the river gets out of its banks a great volume is carried across the peninsula along the line P Q. The velocity, as indicated by the heavy deposits of large gravel, must be considerable. Deep gullies are cut along here in many places. At the point of the threatened cut-off the river has been gradually cutting into the concave bend and moving its apex down-stream. This process will continue until the resistance to the flow of water around the bend at overflow stages will be greater than that straight across or through some old slough above. As the conditions are favorable for a cut-off, the chances are in favor of the former. This may occur at any future winter freshet. Two methods of preventing the threatened diversion of the river-bed present themselves:

(1) *Divert the river above.*—That is to say, lead it across the upper peninsula of the bend, which is all overflowed at ordinary high water, bringing it into the old channel somewhere in the vicinity of the point marked A on the river sketch herewith. This peninsula is, in my judgment, the field of a long-continued aggression of the river into the upper concave bend of the S.

It is densely covered with cotton-wood forest, many of the trees being of great size, and many having evidently died of old age. There are some low swales that would seem at first glance to have been paths of the river across the peninsula; but the probabilities are that they are only evidences of the progress of the river in forming it and of local paths of the high-water discharge. I have seen no strong tendency of the river at any point to cut across this point. All this, taken in connection with the fact that the ground is occupied with stumps and roots of a dense forest, and the fact that the proposition of making a cut-off is one always attended with difficulty and uncertainty and unexpected results at other points, leads me to the opinion that it will not be advisable to attempt it here.

(2) *Revet the concave bank at the threatened point.*—The line to be protected is about 6,000 feet long, as shown on the sketch. If this can be held at reasonable cost it will

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be the proper method, as there will be no disturbance of the regimen of the river, nor of any vested property rights that may have grown up in the vicinity. Two things are essential to this project. One to hold the unstable bank and the other to prevent the high-water discharge from crossing the lower peninsula of the S with velocity sufficient to cause the deposition of gravel and sand on the cultivated land.

It is proposed to revet the whole slope with a brush mattress to some distance below low water, first cutting it down from the vertical to a slope of 1 or 1½ with a hydraulic jet. To make this permanent a growth of willows and cotton-wood should be cultivated over the slope and upon the berme at its crest.

To slacken the current across the lower peninsula at high-water stages it is proposed to lay a braced hurdle 10 feet back of and along the crest of the revetted slope, upon the line shown in the sketch, extending to high-water line. The water will then cover the area below as before, but will pass over it with low velocity, and the deposit will benefit the land. The data for the following estimates are based upon information on file and upon a survey of the Oregon Pacific Railroad along the line of the bank to be protected.

ESTIMATE.

Cutting down slope, 50,000 cubic yards, at 4 cents	$2,000
Mattress description (wattled mattress of willow poles and brush laid continuous from a scow with ways projecting over bank), 20,000 square yards, at 40 cents	8,000
Hurdle description (let 6-inch fir poles 3 feet into the ground at intervals of 3 feet; wattle strongly with brush and cap with double waling of 3 inch by 6 inch timber; brace with 3 inch by 6 inch pieces to a row of similar posts let into the ground about 12 feet behind the hurdle, and spiked on; these posts to project 1 foot above ground), 6,000 linear feet, at 30 cents	1,800
Willow planting and contingencies	1,200
Engineering expenses	1,000
Total	14,000

As the winter freshet had set in when my instructions were received in this matter it was not practicable to make any survey in connection with the examination.

In view of the fact that the threatened cut-off would isolate the city of Corvallis from the river, it seems to me proper that the work should be done.

Very respectfully, your obedient servant,

W. A. JONES,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

It is proposed to apply the appropriation asked for as follows:

Completion of new snag-boat	$7,000
Current operations for maintenance of channel	12,000
Rock removal and wing-dams	7,000
Surveys	3,000
Total	29,000

APPROPRIATIONS.

Act March 3, 1871	$16,000
Act March 3, 1873	3,000
Act June 23, 1874	7,500
Act March 3, 1875	25,000
Act August 14, 1876	20,000
Act August 18, 1878	20,000
Act March 3, 1879	12,000
Act June 14, 1880	12,000
Act March 3, 1881	15,000
Act August 2, 1882	5,000
Act July 5, 1884	10,000
Act August 5, 1886	10,000
Total	155,500

For commercial statistics, see letter of transmittal.

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Money statement.

July 1, 1886, amount available		$15.48
Amount appropriated by act approved August 5, 1886		10,000.00
		10,015.48
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886		7,104.75
July 1, 1887, amount available		2,910.73
Amount (estimated) required for completion of existing project:		
Construction	$7,000.00	
Snag-boat	7,000.00	
Maintenance	12,000.00	
Surveys	3,000.00	
		29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		29,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.		

U U 3.

IMPROVEMENT OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON TERRITORY.

The plan of this improvement consists in submerged-rock blasting and bar-scraping to secure a low-water channel of 5½ feet in the Columbia as far as Ainsworth, and 4½ feet in the Snake as far as Lewiston. The original estimate of cost is $132,000. Total appropriation for this project, $121,000. Amount expended thereon to date, $121,000. The project covers the Columbia River from Celilo, Oregon, to the mouth of the Snake, at Ainsworth, Wash., and the Snake from this point to Lewiston, Idaho.

It was decided in the outset to do the season's work by hired labor, instead of by contract, as had hitherto been done, on account of the excessive prices which had been paid for the kind of work involved, and to make a careful survey of as many of the rapids below Riparia, commencing at Texas Rapids, as the funds in hand would justify.

To this end a large drill-scow was built at Lewiston and completed and furnished with a complete outfit for hand-drilling and blasting in the dangerous rapids of this river. Funds in hand did not justify furnishing her with a steam plant. Her keel was laid October 2, and November 1 she was anchored in Texas Rapids and at work, having been taken down the river 70 miles by her crew of skilled boatmen. Two large skiffs were also built at the same time.

This scow carries a house on deck for quarters, store-rooms, etc., a large projecting platform astern, upon which the drillers stand while at work, and four stout spuds fore and aft arranged with simple tackle for raising her slightly in the rapids while at work, so as to have a portion of her weight carried on the spuds. This, in connection with her anchorings, gives a stable platform from which the drilling can be carried on. The water over the rocks to be removed on these rapids is more or less shallow. The scow is anchored so that the platform rests just above them. Holes are drilled and charged with sufficient powder to break up the rock into such small fragments as the current will carry away. The firing has usually been done by means of time fuses. Sometimes a large charge is laid upon the top of the rock in case of sufficient

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depth of water for efficient tamping. This seems like a simple operation, but in the difficult rapids of this river it requires great skill and judgment.

The following work was done:

	Cubic yards.
Texas Rapids	425
Little Goose Rapids	65
Total	490

At Log Cabin Rapids, where a very narrow channel passes a projecting point of débris from the shore, a strongly framed and ironed crib, 400 cubic yards, was laid around the point for boats to sheer against in passing, and has proven a very satisfactory solution of the question of passing one of the worst places between Riparia and Lewiston.

The crib cost, complete and in place, $950.

The survey party made a detailed examination of Texas Rapids, a place where improvement will be attended with considerable difficulty and expense.

The following was done:

Slopes at high and low water determined.
Low-water velocities determined.
All rocks and reefs located with plane table.
Ample soundings taken.
Low-water discharge determined approximately in a favorable reach below the rapids.
The highest velocity noted was 9.48 miles per hour.
The low-water discharge was found to be 26,346 cubic feet per second.

The following charts of the Texas Rapids have been prepared:

General chart showing soundings, rocks, and reefs.
Sheet of sections.
Longitudinal profile showing slope and bed.

From these it appears that this obstruction results from an insufficient section, especially during low stages, and that such velocities as 9½ miles per hour are developed by the damming effect of the constriction. The river has not yet cut a normal channel through the rocks at this point. Under the project for improvement with which we are now working it will not be possible to do much good at this point except in this, that the rocks we may remove now are a portion of the large quantity which ultimately will have to be removed. Before such extensive operations are undertaken, however, it is very essential that a very careful survey should be made of the whole river below Grand Cañon.

The discharge measurements show Snake River to be of considerable magnitude. The whole slope from Lewiston to the mouth, a distance of 137 miles, is 2.9 feet per mile.

Similar surveys were made at Monumental Rapids, Long Crossing Rapids, and Pine Tree Rapids.

Towards the close of the month of December, as the funds were about exhausted and the season for running ice at hand, both parties were disbanded and the plant laid up at Almota, Wash., where it would be free of danger from ice. It was afterward removed to Lewiston, Idaho, for better convenience in the care of it.

It is to be observed that independent of the cost of plant the removal of the rock in this season's work cost $7.30 per cubic yard. The wear and tear and maintenance of plant should be added to this, but it can not be determined from the operations of one season. It is very easy to see, however, that there has been a large reduction upon the previous cost of doing this work by contract.

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RÉSUMÉ OF MONTHLY OPERATIONS.

September, 1886.

Operations during the month consisted of organizing survey and blasting parties and assembling the necessary men, boats, and material for operations during the season.

October, 1886.

Survey party.—Survey party of nine men left Portland, Oregon, on the 2d instant, and, assembling boats and supplies at Riparia, Wash., reached Texas Rapids on the 7th. Water low and favorable for work. Soundings taken from head to foot of rapids, and a distance of 1,021 feet measured off below the foot of the rapids where there are comparatively few rock obstructions. A great number of soundings were taken amidst the rapids, and required information obtained to show the slope and enable numerous cross-sections of the river to be made. Surface velocities were taken, and plane table work, locating and defining the rocks and reefs, has been carried on over the whole field. A great deal of work in a difficult and dangerous rapid has been accomplished.

Blasting party.—During the month a drill-scow and two large skiffs were built by hired labor at Lewiston, Idaho, under special authority, at a cost of $1,200.

Party was assembled at Lewiston and moved down the river with the boats, and was anchored and at work in the Texas Rapids the day after arrival. A rapid and skillful performance.

November, 1886.

Operations directed to removal of submerged rock from rapids at Texas Ferry and Little Goose Island, and to the survey of rapids at Texas Ferry and below.

Blasting party.—Operations on drill-scow commenced 1st instant at Texas Rapids. The rapids of Snake River are so swift and rocky that handling the scow in them is very difficult and dangerous work.

Working party consisted of 1 overseer, 1 foreman, 1 blacksmith, 1 helper, 1 carpenter, 1 store-keeper, 3 boatmen, 8 drillers, 1 cook, 1 cook's helper.

Up to the 14th instant 125 cubic yards of rock had been removed, when the scow was ordered up to Little Goose Island and put to work on a number of small bowlders widely scattered about along the channel. By the 21st these were all removed, amounting to 65 cubic yards, and the scow dropped down to Texas Rapids and resumed work at that point. In 21 days 190 cubic yards of rock were removed. This at last year's contract price, $18 per cubic yard, would have cost $3,420. The entire expense of this party, including all supplies whatever, does not exceed $1,800 per month.

Survey party.—Operations were continued upon survey of Texas Rapids and platting field work to be furnished in time to direct blasting work at same place. Work was completed here on the 13th, and on the 14th the party dropped down to Monumental Rapids, 21 miles below. Remained here until the 24th, completing the survey at this point, and moved down to Long Crossing Rapids, where operations were continued until end of the month.

Survey party composed of 1 assistant engineer, 1 transitman, 2 recorders, 4 boatmen, 1 cook, 1 mess boy.

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December, 1886.

Survey party.—Survey of Long Crossing Rapids completed on 4th instant. On the 5th and 6th instants measurements for low-water discharge were made at favorable point in the vicinity.

On the 9th instant the survey of the Pine Tree Rapids having been completed, the party, under original instructions, dropped down to Ainsworth. Men, stores, and camp equipage were shipped to Riparia, and the party proceeded in its boats to Celilo, and from there to Portland by rail, where it was disbanded on the 18th instant.

Blasting party.—Operations continued at Texas Rapids; 300 cubic yards of rock removed. Party disbanded on the 29th instant, and drill-scow and plant laid up at Almota, the nearest point where it would be safe from moving ice.

It is proposed to apply the appropriation asked for to submerged-rock blasting in the rapids and the removal of cobble-stone bars between Riparia, Wash., and Lewiston, Idaho.

APPROPRIATIONS.

Upper Columbia River:		
Act June 10, 1872	$50,000	
Act June 23, 1874	20,000	
Act March 3, 1875	35,000	
		$105,000
Upper Columbia and Snake rivers:		
Act August 14, 1876	15,000	
Act June 18, 1878	20,000	
Act March 3, 1879	20,000	
Act June 14, 1880	15,000	
Act March 3, 1881	15,000	
Act August 2, 1882	6,000	
Act July 5, 1884	20,000	
		111,000
Upper Columbia River, including Snake River:		
Act August 5, 1886		10,000
Total		226,000

For commercial statistics, see letter of transmittal.

Money statement.

July 1, 1886, amount available		$2,371.60
Amount appropriated by act approved August 5, 1886		10,000.00
		12,371.60
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	$12,345.45	
July 1, 1887, outstanding liabilities	26.15	
		12,371.60
Amount (estimated) required for completion of existing project		26,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889		26,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

U U 4.

IMPROVEMENT OF LOWER CLEARWATER RIVER, IDAHO.

The plan here is to make a channel through rock reefs and cobble-stone bars over a distance of 40 miles above Lewiston, to secure a depth of 4 feet at low water. The original estimated cost was $34,424. Total appropriation to date, $15,000. Total expenditures, $15,000. No funds

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have been available during the fiscal year, and there are no operations to report. It is proposed during the coming year to complete the project. This line will tap an exceedingly rich and productive country, and when the small cost of the improvement is considered, it seems advisable to complete it at once.

APPROPRIATIONS.

Act March 3, 1879	$5,000
Act June 14, 1880	5,000
Act August 2, 1882	5,000
Total	15,000

For commercial statistics, see letter of transmittal.

Money statement.

Amount (estimated) required for completion of existing project	$19,424.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	19,424.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

U U 5.

IMPROVEMENT OF COWLITZ RIVER, WASHINGTON TERRITORY.

The plan of improvement of this river consists in wing-dam construction, bar-scraping, and snagging operations, to secure light-draught navigation up to Toledo, a little more than 30 miles above the mouth.

The original estimated cost of this work is $3,000 for the first year and an annual expenditure thereafter of $2,000 for maintenance. The amount expended to the end of the fiscal year is $8,000.

The work of improvement on this river has made a commercial development very large in proportion to the amount expended, and I am of the opinion that operations should be extended to Klikitat Bridge, about 20 miles above Toledo, and also to include shore-protection where necessary. The estimate submitted has this extension in view.

OPERATIONS.

October, 1886.—The steamer *Toledo*, engaged in snagging operations, bar-sluicing, rock-blasting, and wing-dam construction.

At Stock's Bar a dam 90 feet long and 2½ feet high, containing 250 sacks gravel and 12 cords of brush, was constructed, and at Jones's Bar 4 large rocks were blasted out and removed.

November, 1886.—Operations under the present appropriation completed. Over the reach of 30 miles from Toledo to the mouth of the river a navigable depth of 2½ feet was gained at extraordinary low water. The river was full of snags and stumps of enormous size, mostly buried in the sand and gravel, and in many places there was but 15 inches water. These snags and stumps were removed by liberal use of giant powder. The bars were deepened by sluicing, horse-scraping, and shoveling. Just below Toledo the river was diverted by digging a new channel 1,200 feet long and the river turned into it.

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A wing-dam was constructed at Stock's Bar 100 feet long, containing 250 tons gavel and 50 cords brush, and a depth of water obtained on the bar of 3½ feet.

Month.	Wing-dam constructed.	Snags removed.	Kind.
	Feet.	*Number.*	
October	90	238	Ash, fir, and willow.
November	100	77	
Total	190	315	

Particular attention is called to the very successful and economical season's operations on this river. At an expenditure of $2,000 a reach of 30 miles of river, carrying very many embedded snags and stumps and extremely obstructed by shallow bars, was cleared so as to afford a draught of 2½ feet of water at a low-water stage, lower than any that has hitherto been observed.

APPROPRIATIONS.

Act June 14, 1880	$2,000
Act March 3, 1881	1,000
Act August 2, 1882	1,000
Act July 5, 1884	2,000
Act August 5, 1886	2,000
Total	8,000

For commercial statistics, see letter of transmittal.

Money statement.

Amount appropriated by act approved August 5, 1886	$2,000.00
July 1, 1887, amount expended during fiscal year, exclusive of liabilities outstanding July 1, 1886	2,000.00
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1889	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

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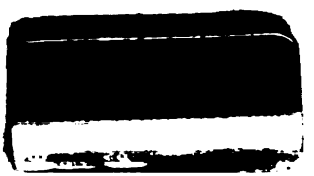

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